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Eco-Design Innovation in Small and Medium Sized Enterprises.

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B.Sc. (Hons), M.Sc.

A Thesis submitted to the Open University
in partial fulfilment of the requirements for
the degree of Doctor of Philosophy.

The Department of Design and Innovation

Technology Faculty

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Abstract.

Increasing pressure on industry from a range of interest groups has placed environmental concerns at the centre of social and political agendas. This is reflected in policies that aim to effect the 'greening' of industry. The focus has been on the environmental impacts of larger corporations. Small and medium sized enterprises (SMEs) have received relatively little attention, although their economic and environmental significance cannot be ignored.

This research investigated a group of environmentally motivated SMEs to identify policy measures that would promote 'green' product and service innovation. The project draws on data from 14 case study interviews to distinguish the key factors that led to the marketing of their 'green' products and services. Interviews were also conducted with policy makers and SME support agencies in the UK and the Netherlands. This enabled a comparison of schemes available for the promotion and further development of ecologically designed products within this sector.

The 'Eco-wheel', created as a means of introducing Dutch SMEs to environmental design issues, was adapted to identify the environmental profiles of the 'green' products in this study. This technique proved inappropriate for the analysis of service oriented firms and an alternative systems-based model was developed. The general business environmental profiles revealed that the enterprises could be categorised 'light' or 'dark' green.

The analysis indicated these firms were not the stereotypical reactive SME portrayed in the literature. Legislation and industrial standards, while instrumental in improving the environmental performance of the majority of SMEs are inappropriate as drivers for innovation in the 'green' firms. This 'green avant garde' typically sought commercial advantage through their commitment to environmental and business excellence within their niche markets.

The research suggests that to further stimulate these 'green' niche markets a radical policy framework is required. This would ensure: a) access to low-risk venture capital for Research and Development; b) the effective dissemination of reliable environmental information; c) financial rewards for consumers and producers of 'green' goods and services, delivered through tax incentives and subsidy programmes. These initiatives could contribute to effect technological and system level innovations that will ensure the transition to a more sustainable future.

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Chapter 1: Introduction to the Thesis.

1.1. Introduction.

This chapter provides an introduction to the research study and the structure of the thesis. This project focused on a group of small and medium sized enterprises (SMEs) which had developed and marketed 'green' goods and services. 'Green' implies that environmental issues have been incorporated into some aspects of the design of the products or services. Eco-design is a further development of this strategy, and is the systematic process by which environmental impacts are minimised at each stage of a product life cycle. The study focused on a group of UK based small firms that had marketed such goods. The study chose to concentrate on small firms for two reasons. They are the most abundant form of business and capable of producing innovative goods and services. It was intended to gain greater appreciation of the barriers and opportunities faced by small, 'green' companies, and identify policies that could be implemented to benefit such enterprises. It directly led to further research into SME support agencies in the UK and the Netherlands. This chapter outlines the area of the research and an introduction to the role of SMEs in the process of industrial transformation. It is followed by an overview of the research aims and objectives, and an outline of the structure of the thesis.

1.2. The Focus of the Thesis.

There has been considerable research into small business issues and the way in which environmental issues have affected business practices. Comparatively little has been done that combines both these areas and focuses on product or service design from an environmental perspective. The project investigated how eco-design ideas were translated into commercial practice in a group of small, independent UK firms. The research analysed existing approaches to eco-design in a small business context, and investigated the barriers and opportunities for the integration of such innovations and practices in other enterprises. The research investigated the scope for future environmentally inspired innovation and identified policies that could stimulate further growth and development of these businesses. The initial survey informed further interviews with SME support agencies and eco-design practitioners in the UK and the Netherlands.

1.3. Defining a 'Small and Medium Sized Enterprise'.

There is no single definition of a SME, although most are based on classifications of number of employees or turnover. The most appropriate classification for this study is the typology used by the European Union (EU), and listed in Table 1.

Table 1.1. Definitions of SME.

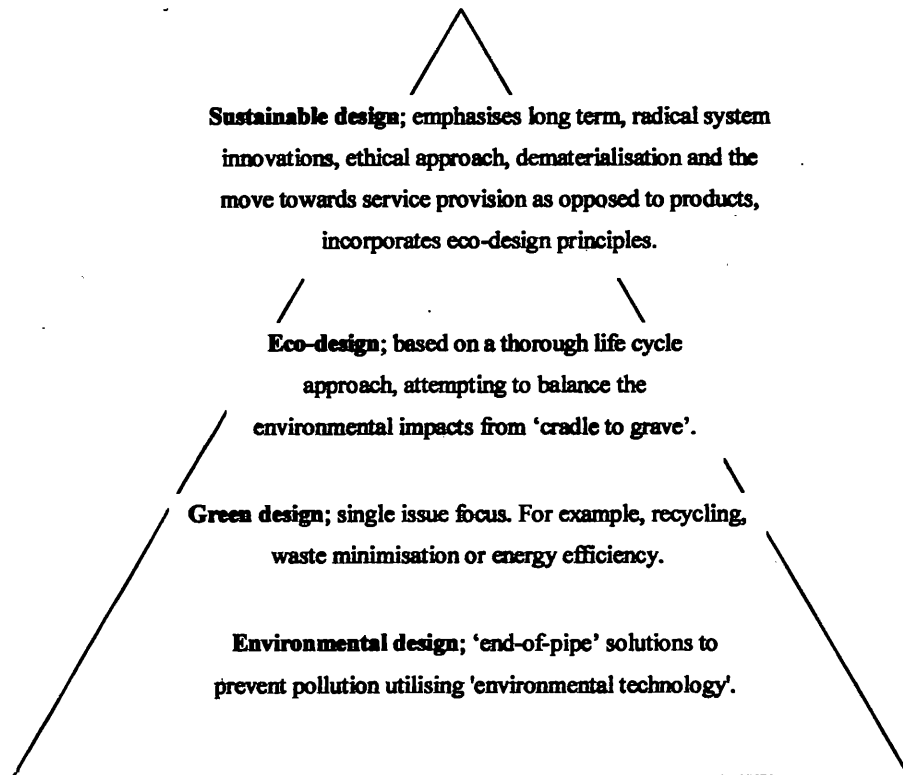
Definition	Operational Characteristics
An SME	Has fewer than 250 employees, and either An annual turnover not exceeding ECU 40 million, or An annual balance sheet total not exceeding ECU 27 million, and Is an independent enterprise, i.e. 25% or more of the capital or voting rights cannot be owned by a larger enterprise.
A small enterprise	Has fewer than 50 employees, and either, An annual turnover not exceeding ECU 7 million, or An annual balance sheet total not exceeding ECU 5 million, and Is an independent enterprise, i.e. 25% or more of the capital or voting rights cannot be owned by a larger enterprise. CEC, (1996)
Micro-enterprise	Those with between 0 and 9 employees
Small enterprises	Those with between 10 and 99 employees
Medium enterprises	Those with 100-499 employees. Storey, (1994)

UK Government statistics indicated that 99% of all UK enterprises are those with fewer than 50 employees (DTI, 1996). For reasons that will be explained in Chapter 2, the most interesting form of business for this study is that which has developed beyond a 'micro-scale' enterprise. A flexible approach to the definition of small firm was adopted, although 'sole traders' were excluded. The study addressed firms that had more than 10 employees, and therefore defined as small or medium sized. This included businesses that operated as partnerships, networks or sub-contracted the manufacturing element.

1.4. Introduction to Small and Medium Sized Enterprises and Environmental Issues.

This introduction provides an overview of the subject studied, developed in greater depth in Chapter 2. In response to threat of local and global environmental problems, governments have introduced policies to prevent excessive degradation. A hierarchy of strategies to meet environmental objectives, from environmental technology to sustainable design has emerged. The implications for product and service design will be explored more fully in Chapter 2. The various approaches are summarised in Figure 1.1.

Figure 1.1. Hierarchy of 'Environmental Technology' to 'Sustainable Design'.



Source: Dewberry and Goggin, (1996).

There has been an increase in commercial interest in 'green' issues arising from greater pressure from consumers, regulatory bodies and financial institutions. This has been partly stimulated by the Rio 'Earth Summit' (Grubb et al, (1993) which gave rise to the term 'sustainable development'. In practice, this will affect patterns of consumption and production, and demand changes in lifestyles.

Some businesses have integrated environmental issues into their practices, and are using it to their strategic competitive advantage. Environmental factors are important elements in the general restructuring or industrial transformation of developed economies. The restructuring has generated renewed interest in the role of small firms. There is increasing recognition of the employment creation, economic contribution and innovative capacity of SMEs. They are viewed as a source for creating new, sustainable technologies and services, and making a valuable contribution to the long-term aims of sustainable development in a business context.

1.5. Area for Investigation.

Most effort in transforming businesses has concentrated on the 'greening' of non-green enterprises. These techniques include the application of management systems and control of industrial pollution arising from processes which have so far been employed largely in a large enterprise context, as will be detailed in Chapter 2. Some of the pressure to conform to higher levels of environmental performance is beginning to affect small firms.

Industry is being compelled to integrate environmental issues with other business practices by the emphasis placed on economic benefits that arise from reducing waste and using energy more efficiently. There has been comparatively little attention devoted to promoting the benefits of introducing environmental considerations into design strategies, particularly in small businesses.

There is a great body of research into small firms and their scope for innovation, and will be explored more thoroughly in the following chapter. This research has a tendency to confuse firms that manufacture tangible goods with those that provide services. Considerable research has been conducted into high technology firms because of their potential contribution to the economic and employment benefit of the country, and therefore of interest to investors and Government alike.

This study sought to understand how environmental issues have been integrated in the innovation process. The information for the study was obtained by a series of interviews conducted with a selection of suitable small and medium sized firms. A qualitative research framework was employed to explore various aspects of the businesses, and the analysis of the themes that arose is presented in Chapters four to six.

This research led to additional interviews with business support agencies in the UK and the Netherlands. The Netherlands was chosen because eco-design and its promotion through Government policies are considerably better developed than in the UK.

1.6. Research Aims and Objectives.

The aim of the thesis was:

- The key aim was to understand some of the design, innovation and developmental aspirations of small firms that have produced and marketed 'green' goods and services. The study intended to contribute to knowledge of these kinds of firms, and what forms of intervention might promote their growth and development.
- Conduct a review of secondary data sources that would inform and shape a suitable research project. This would focus on gaps in the literature.
- To investigate the background, philosophy and environmental objectives of small firms. Their views on environmental policy would identify how such policies have aided or inhibited innovation, or were appropriate to SMEs.
- To identify problems and solutions to accessing environmental information, Government initiatives and financial support.

The objectives included:

- To map the similarities and differences between SMEs which have developed green products or services, with a view to developing a framework or typology of 'green' firms.
- To inform policy initiatives in support of 'green' SMEs.
- Evaluate policy framework with the intention of informing policy.
- Learn from the research process, re-evaluate the methodology employed and assess the appropriateness within the context of this study.
- Disseminate research findings through publications, seminars and conference papers. These are listed at the end of the thesis.

1.7. Structure of the Thesis.

The thesis is composed of four main sections divided into eight chapters:

Topic 1. A Literature Review. This provides an overview of the subject and informs the primary research.

Topic 2. The Methodology. This outlines the nature of the research questions addressed and the philosophical and practical implications of the inquiry.

Topic 3. Analysis and Conclusions. The results of the research are covered in four chapters, drawing on interviews with businesses and SME support agencies, culminating with a chapter that presents the conclusions and avenues of further research. The first part of the analysis assesses the business background, environmental issues and the innovation process. The second details the environmental profiles of the 'green' products that entailed the use of the eco-wheel (Hemel, 1998). It was originally developed for assessing the strategic environmental options in product innovation, and used to assist Dutch SMEs. The third assesses the environmental dimensions of services. The final chapter outlines the policy options for intervention raised in the interviews, and compares eco-design initiatives in the UK and the Netherlands.

Topic 4. The last chapter in the thesis contains the conclusions and some areas for future research.

The structure and contents of the thesis are shown in Figure 1.2.

There is a list of publications arising from the research, a bibliography and one Appendix, the interview schedule, at the end of the thesis.

Figure 1.2. Structure of the Thesis.

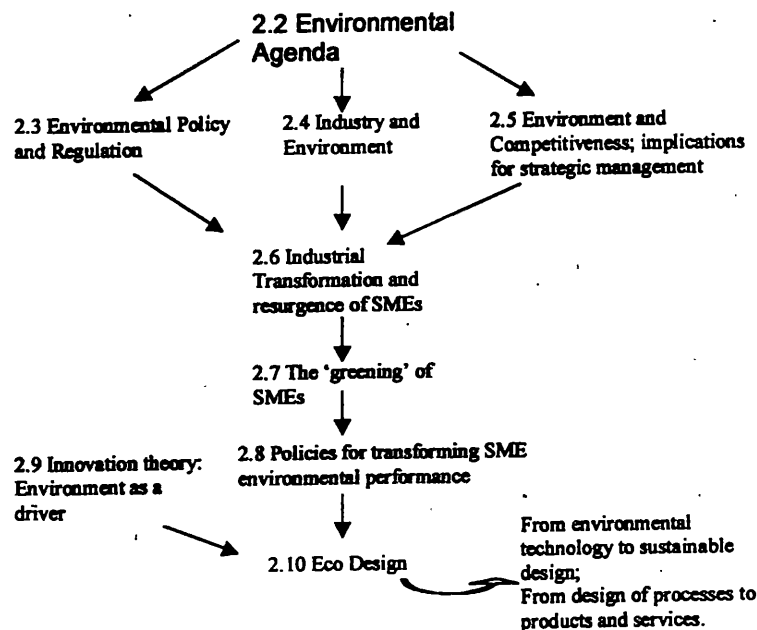
Chapter 1. Introduction	
Chapter 2. The Literature Review	The Environmental Agenda, evolution of environmental policy; Industry, the environment and competitiveness; Industrial transformation and SMEs; The 'greening' of SMEs; Policies for improving SME environmental performance; From environmental technology to sustainable design; emerging research questions.
Chapter 3. Methodology	SME selection criteria; Designing the study; Detailed research questions; Case studies of 'green' SMEs; Grounded analysis; SME support agencies in the UK, and eco-design initiatives in the Netherlands.
Chapter 4. Analysis: Background, Environmental Issues and Innovation	The business environment; Strategies for growth; Environmental issues; Innovation
Chapter 5. Design for the Environment (DFE) Strategies	The eco-wheel for analysing the environmental impacts of products and strategic design options.
Chapter 6. Analysis of Environmental Impacts of Services.	Analysis of dynamic business relationship; The business organisation; The business environment; Clients; Information and communication; Direct and indirect environmental impacts of the service.
Chapter 7. Policy Implications. A Review of UK and Dutch Policies.	SME policy issues; Dutch and UK eco-design initiatives; Intervention for transformation
Chapter 8. Conclusions.	Summary of the main research findings; Policy options for supporting 'green' SMEs; Environmental innovation; towards a typology of 'green' SMEs; Future directions for eco-design research.

Chapter 2. Literature Review.

2.1. Introduction.

This chapter provides the background literature that frames the thesis. It draws together a number of theoretical issues combined with empirical research. The theoretical background is a synthesis of post-Fordist industrial transformation, the emergence of strategies designed to address environmental issues, and the role of Small and Medium Sized Enterprises (SMEs) in developing innovative solutions arising from the demand for environmentally conscious goods and services. The elements and structure of the chapter is shown in Figure 2.1.

Figure 2.1. Structure of Chapter 2.



Over the course of ten sections, the chapter traces the development of the environmental agenda regarding the over exploitation of natural resources and the degradation arising from resource depletion and pollution caused by industrial waste emissions.

These concerns challenge the proposition that economic growth, material well-being and accelerated resource consumption are inevitable and inextricably linked. This leads to an evaluation of practices within a post-industrial society that has implications for resource management and curtailing pollution. This process is accompanied by massive restructuring in industry coupled with a resurgence of interest in SMEs, not least because of their innovative capabilities. Various policies have been enacted to provide support for SMEs to achieve both economic and environmental objectives. Some firms have responded to the environmental agenda by exploiting various technologies and practices that give them a competitive advantage in the market place. Innovation includes reactions to environmental issues as threats and opportunities, where small firms could benefit while contributing to a more sustainable future.

2.2 The Environmental Agenda

This part of the chapter is an overview for picking out key broad issues that impinge on the research agenda. It is appropriate to start with a discussion of the evolution of the environmental agenda. Global ecosystems are continually subjected to a range of processes and pressures. These processes are geological and environmental, and those arising from human activity. Concerns about the welfare of the planet can be divided into four types; acute or catastrophic, chronic, reversible and irreversible. They are summarised in Figure 2.2.

Figure 2.2. Classification of Environmental Issues.

	Short Term	Long Term
Reversible	Noise pollution	Climate change, pesticides
Irreversible	Catastrophes (e.g. Bhopal)	Extinction of species

The accidents at Bhopal, Chernobyl and Seveso are examples of catastrophic events (Hutchinson and Hutchinson, 1997).

The long term, or chronic effects of human activity include concerns about the effects of climate change (Roberts, 1994; IPCC, 1996) and the use of pesticides (Carson, 1965).

Noise pollution is a localised and reversible environmental problem, while extinction of a species is clearly an irreversible loss of biological diversity, or biodiversity. Observations of these problems are not exclusively a modern phenomenon. The implications of soil erosion in both the USA and Europe have been recorded over the past few centuries (Mannion and Bowlby, 1992). Agricultural practices have also left their mark on the appearance of the countryside (Rackham, 1986) and influenced the emergence of the conservation movement. Post-war perceptions of nature can be traced to The classic Sand County Almanac (Leopold, 1949), affected the way the natural environment was viewed. The roots of the political ecological movement, including the Sierra Club in the USA, can be traced to this influential book. The idea that human actions alone have produced environmental degradation is an oversimplification. In reality, man has modified the planet, unwittingly by the accidental *and* deliberate introduction of animals and plants into non-native territories, or through the eradication of species. This constitutes a particular form of pollution. This thesis is mainly concerned with efforts to recognise, understand and ameliorate environmental problems caused by economic activity in an industrialised society. Principal environmental issues are characterised by resource depletion (e.g. soil erosion, mineral extraction) coupled with unpredicted effects; namely localised and global damage (water-course pollution and global climate change). Much of the environmentally guided political debate centres on issues of equity of access to resources and resource allocation, and resolution of the dilemma of maintaining economic development while conserving resources. This has been summarised by what McLaren et al (1998) refer to as three parts of 'the limits to environmental space':

- The carrying capacity of ecosystems (the sustainable supply of renewable resources including food and timber);
- The recuperative ability of the natural environment (its ability to absorb our wastes and pollutants); and

- The availability of non-renewable raw materials (fossil fuels and minerals).

Developments in understanding environmental systems enabled connections between cause and effect, which may be immediate, localised damage, or long term effects, geographically and temporally dispersed.

An example of the latter type is the connection between acid rain deposition and coal burning power stations (Boehmer-Christiansen and Skea, 1991). Environmental issues are often linked with health issues. For example, the potential unpredicted long-term effects of exposure to herbicides and pesticides were first notably described in 'Silent Spring' (Carson, 1965), which indicated one of the main problems of addressing the effects of pollution. Perhaps the uniting theme within the environmental movement is the concept that the earth's resources are theoretically finite, and that the biosphere could be damaged beyond recovery. This is the implication of the 'Ehrlich hypothesis', which relates the scale of environmental damage to three main factors, expressed as a mathematical equation;

$$I = P \times A \times T$$

The total environmental impact of human activity = Population size x Affluence or consumption patterns x Technology

Source: Ehrlich and Holdren (1971).

In essence, only population can be calculated with any degree of certainty, since the other two variables are subject to considerable, and continual, debate. This hypothesis has been the basis for arguments limiting population growth, changing consumption patterns, and introducing new forms of 'environmentally friendly' technologies. Such thinking was a component of early computer models designed to explore the effects ('overshoot') of predicted population growth and consumption patterns, which informed the still influential 'Limits to Growth' (Meadows et al, 1979) and the sequel, 'Beyond the Limits' (Meadows et al, 1995). In the initial computer simulations, the authors concluded that even under the most optimistic conditions, there would be an overshoot of the physical limits to the carrying capacity of the earth because of resource depletion and pollution. Another technique for visualising the environmental 'overshoot' dilemma is the 'ecological footprint' of the built environment (Wackernagel and Rees, 1996).

This enables the calculation of the land and resources needed to sustain a town or city, and is analogous to various product environmental-profiling tools, described in more detail in this chapter.

Beder (1994) argued that moderating population growth and consumption patterns were non-negotiable, since nations were unable to reach agreements on these aspects at the Rio Earth Summit in 1992. In her opinion this implied that technology is the politically least sensitive option that could be manipulated. Harper (1996) also concluded that new forms of technology and the change in balance between the developed world and emerging nations may become more significant than absolute population growth in the near future. This is an important theme that puts an emphasis on product design responses and therefore directs the research effort of this project.

The idea of limited natural resources has dominated arguments for equitable and rational global distribution of those resources (McLaren et al. 1998) for the benefit of all, including future generations. Such a vision was clearly expressed by the World Commission on Environment and Development, in the so-called Brundtland report (WCED, 1987). The momentum built by this report culminated in the 1992 United Nations Conference on Environment and Development, (UNCED) more popularly known as the Rio 'Earth Summit', which resulted in five major agreements with many of the governments represented. These included;

- The framework convention to ameliorate climate change,
- Convention on the preservation of biological diversity,
- An action plan for sustainable development, known as 'Agenda 21',
- The Rio declaration concerning the need for development and alleviation of poverty,
- The forest principles that govern the right to manage and exploit forest resources.

Source: Grubb et al. (1993).

For some time the environmental movement held that economic growth and environmental protection was mutually incompatible. However, the newly emerging branch of environmental economics challenged this view. Pearce et al. (1989) in 'The Blueprint for a Green Economy' suggested that the theoretical limits of resource depletion and ultimate system overload would be avoided through material substitution, recycling or other technological revolutions, and could be achieved through a combination of market forces and regulation. The zero-growth sentiments have largely been replaced by the sustainable development position encapsulated in the Brundtland Report as 'one that meets the needs of the current generation without compromising the ability of future generations to meet their own needs'. (WCED, 1987).

The environmental position ranges from pessimism to a more pragmatic, optimistic and expansive outlook, asserted as sustainable development. Environmentalism and sustainability is closely allied to a post-modernist view of society. It accepts the position of scientific uncertainty and the inherent complexity and chaotic properties of natural systems (Lyotard, 1992). Uncertainty introduces two closely related ideas, risk assessment and the 'precautionary principle'. The latter implies that it is preferable to exercise caution based on imperfect knowledge rather than wait for 'scientific proof' of potentially disastrous, but foreseeable events to occur. Risk assessment is the art of estimating and minimising such probabilities. It follows that necessary action is needed to deliver change that can be delivered at a sufficient rate by a cocktail of technological advances, market forces and regulation.

This very brief introduction to the evolution of post-war environmentalism emphasises the greater understanding of:

- The effects of pollution
- Resource depletion
- Limits to both, and the tolerance of natural systems to human activity.
- The ability to differentiate human activity from background, long period cycles.

- The three main components of human activity, namely population, consumption patterns and technologies.

Politically, the least controversial aspect is technology. There is increasing effort directed at remedying environmental damage and mitigating the effects of global climate change. This theme shapes the research programme by focusing on the sources of environmentally benign technologies. In a market economy, businesses strive to gain competitive advantages. The environment is now viewed as one such strategy, and the business response has evolved within a framework of regulation, industrial transformation and renewed interest in small firms as innovators.

2.3 The Evolution of Environmental Policy and Regulation.

It is a European level policy goal to reconcile economic growth, employment and industrial competitiveness with high levels of environmental protection (ECFESD, 1998). Environmental regulation has developed in response to concerns of widespread environmental degradation, for example, the 'State of the Environment' (OECD, 1991). By 1990, a wide range of environmental legislation had been passed, with the intention of reducing air, water and noise pollution, protecting wildlife and preventing industrial accidents (Welford, 1996). In a market economy, intervention is required to correct failures. In environmental terms, this can be represented by pollution, where the costs of emissions are not borne by the producers, and are regarded by economists as 'externalities'. Intervention has been regarded as necessary to protect the environment, and to send the message to industry that wasteful raw material extraction, consumption and disposal practices are no longer tolerated. To achieve these policy objectives, the EU initiated the Fifth Action Programme for the period 1992-2000, 'Towards Sustainability' which also ensured that policy makers must take environmental issues into consideration.

This builds on its declaration;

"Pollution is no respecter of national borders: it carries on the wind and water and damages environments far distant from its point of origin...Aiming at a high level of protection, the Union's current policies extend far beyond air and water quality to include the protection of soils, habitats and fauna and flora, and the conservation of wild birds."

DGXI, (1999)

The Directorate General (DG) expands on this theme of environmental protection, and declares that the Treaty on European Union strengthened existing powers to include measures for:

- Preserving, protecting and improving the quality of the environment;
- Protecting human health;
- Ensuring a prudent and rational utilisation of natural resources;
- Promoting measures at the international level to deal with regional or worldwide environmental problems.

This includes the aim of rectifying damage at source, promoting preventative action and making the polluter pay. The measures enacted are summarised in Table 2.1.

The instruments employed to achieve these aims include directives for controlling industrial plant emissions, pesticides and hazardous waste, funding programmes for encouraging energy efficiency, and voluntary schemes for product labelling (CEC, 1992). This shifted the emphasis to improving the enforcement of existing legislation. It also moved away from traditional command and control mechanisms to include market based instruments, such as the proposed carbon tax, and voluntary agreements, including Ecolabelling and eco-management and audit schemes.

The main focus has been on regulating industrial practices through process control and pollution abatement, reflected in the close relationship between environmental issues and health and safety.

Table 2.1. A Summary of EU Sustainability Measures planned up to 2000.

Objectives	Measures up to 2000
Sustainable use of natural resources	<ul style="list-style-type: none"> Internalise external costs Create markets for recycled goods Set targets for minimum reuse limits Improve physical and strategic planning
Prevention of pollution through management and control of production processes, diffuse emissions and products	<ul style="list-style-type: none"> Use of 'clean' technologies Integrated pollution prevention and control Environmental audits Environmental impact assessment Environmental charges Emission limits Development of ecologically friendly goods Specific reduction or limitation programmes, mainly atmospheric pollutants Improve industrial & safety research Improve chemicals management
Prevention and/or safe disposal of waste	<ul style="list-style-type: none"> Waste management plans in all member states Reduced waste/better waste management
Facilitating change towards a more sustainable behaviour of economic agents	<ul style="list-style-type: none"> Awareness building and incentives aimed at sustainable energy use Development of information on goods and processes Stimulate investment, innovation and competitiveness Development of 'clean' technologies.

Source: based on Hunter et al. (1997).

The regulatory framework for producer responsibility is generally well established, and the latest round of measures serves to enforce existing policies.

Coupled with this is the introduction of softer measures, including efforts to influence consumption patterns through stimulating investment, innovation and competitiveness and voluntary codes for defining and promoting environmentally preferable goods.

A recent development has been the proposal for an Integrated Product Policy (IPP), which aims to combine a raft of measures relevant to product systems. One outcome is likely to be greater responsibility placed on manufacturers of certain product groups for the entire product life cycle, including end of life recovery systems (DGXI, 1998).

The implications for industry are clear. There is an increasing volume of environmental regulation that will be more rigorously enforced, so compliance will also become more important as will an appreciation of future directions. There has therefore been an historical trend of moving from pollution prevention (end of pipe) legislation, enforced through command and control directives, to more market focused, product based regulations, including energy and eco-labelling. While the prime targets for regulation has been the large, energy and resource intensive industries, SMEs are receiving greater scrutiny. The initiative has passed back to industry to accommodate environmental issues as a major force shaping future directions.

2.4 Industry and the Environment.

Three perspectives emerge from the literature review that structure the thesis:

- The first addresses the industrial response to environmental issues.
- The second treats the problem as a restricted technical system that can be physically repaired, or rectified through Government intervention, such as tax reforms.
- The final perspective argues for an organisational approach that requires evolutionary, systemic changes.

In response to the traditionally anti-industrial environmentalist movement, industry has developed strategies designed to address environmental issues, coupled with the introduction of previously described environmental policies, legislation and other competitive pressures (Groenewegen and Vergraght, 1991).

These have been prompted by the acknowledgement of industry that environmental degradation from pollution is a direct consequence their activity (Schot and Fischer, 1993), and contrary to Friedman (1970) the distinctions between the strict economic goals and social obligations of business have become blurred. The industrial responses to environmental issues, including the regulatory framework in which they operate can be viewed as aspects of ecological modernization (see for example Gouldson and Murphy, 1998; Murphy and Gouldson, 1997; Hajer, 1995). In essence this idea integrates economic and environmental goals within a framework of industrial modernity. It is characterised by two positions. Firstly, ecological modernization seeks to impose a policy framework that promotes macro-economic structural changes. This is engendered through a shift away from energy and resource-intensive industries towards value and knowledge-intensive industries. Technological changes will result in a less environmentally damaging society that consumes fewer resources and generates less waste while creating employment and guaranteeing economic welfare. The second aspect emphasises the role of entrepreneurship, innovation and diffusion of new technologies and techniques. This is based on the creation of cleaner production and technologies, which acknowledges that no product or process is wholly 'clean', and continuous improvements in techniques will steadily reduce waste emissions (Christie, 1995). Clean technologies will need to be coupled with environmental management systems rather than limiting reliance on environmental technologies. Ecological modernization also recognises the inherent weaknesses in the market mechanism, and therefore accepts the need for intervention to prevent the over-exploitation of natural resources and excessive pollution.

Central to ecological modernity is the idea of eco-efficiency, articulated by Weisacker et al, (1997), and defined by Schmidheiny (1992) as;

“Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth’s carrying capacity.”

World Business Council for Sustainable Development (WBCSD)

This has been simplified by the OECD as “the efficiency with which ecological resources are used to meet human needs” supplemented with a goal of achieving “substantial improvements in resource productivity, for example by a factor of four and eventually of ten” (ENDS 279, 1998c). The main ideas are embodied in seven principles:

- Minimise material intensity of goods and services.
- Minimise energy intensity of goods and services.
- Eliminate dispersion of toxic substances.
- Improve material recyclability.
- Maximise use of renewable resources.
- Extend product durability.
- Increase the service intensity of goods.

Put simply, this entails doing more with fewer resources. Weisacker et al (1997) extended this thesis with examples of the synergistic, or multiplier effects that arise from a series of co-ordinated product and process modifications. The authors claimed that environmental gains made in this way far exceed individual, piecemeal change. An alternative perspective known as industrial ecology (see for example Graedel and Allenby, 1994; Ayres, 1989; Tibbs, 1992) has evolved that contrasts with eco-efficiency.

This approach aligns industrial activities more closely with ecological principles. In essence, it treats industry as an interrelated and interdependent network, where industrial processes mimic natural systems. As such, it draws on the Gaia view of global ecosystem dynamics (Lovelock, 1979). Producer responsibility for technology is heightened, and cyclic material flows encouraged. This encourages a 'zero emissions' or 'closed-loop' approach, where there is no concept of 'waste' within the whole system (McDonough and Braungart, 1998; Baba et al. 1997). The technique encourages the close proximity of industrial partners to reduce the impacts of transport, and the waste from one manufacturer becomes the raw material input for another. Industrial ecology implicitly favours 'design for recycling' or re-manufacturing, and these issues will be explored in greater depth. There is comparatively little practical experience of industrial ecology in the UK, apart from a link up between a brewery and a mushroom business (ENDS 291, 1999a) and an industrial park in the Scottish Borders (Talbot, 1998).

The second perspective combines technological and economic thinking, and implies the transition to a more sustainable future can be delivered through conventional market based economic principles. Daly (1992) advocates the use of 'tradable permits' for limiting pollution, while Pearce et al (1989) and Burke (1997) regard taxation as an appropriate route for securing improved environmental conditions.

Finally, some authors adopt a mixture of ecological and Darwinian or evolutionary frameworks that suggest approaches to intervention that could result in regime change. Green and Miles (1996) outline an evolutionary approach to economics, where technological innovation trajectories are determined by a combination of companies, government regulation and market conditions that frame the selection environment, which is periodically subjected to external shocks. Himmelberger and Brown (1995) concur with this view that radical, neo-classical and ecological approaches have all merged. Kemp et al (1998) argue that niche management solutions, such as car sharing to overcome the problem of congested inner cities, can become a dominant regime in the presence of controlled intervention. Fleming (1996) contends that policies need to address outputs rather than inputs to deliver what he terms a 'lean economy' that also has potential for averting social disasters.

Common to all these ideas is that 'technological push' has given way to 'market pull'. Bernardini and Galli (1993) suggested that a process of substitution of services for products could displace energy and material intensive activities. For example, telecommuting may eventually replace physical travel. The substitution model implies a process of dematerialisation, another aspect of eco-efficiency, which focuses on functions and needs rather than an incremental improvement to current practices (Dobers and Wolff, 1999). Both Tuppen (1998) and James (1999) both warn against over optimism in eco-efficiency. They argue that gains made by unit improvements in efficiency will be more than offset by the increased number of units consumed, and substitution is unlikely to translate into environmental improvements.

For example, Freeman (1996) noted that telecommuting has not produced a reduction in overall transport volume, but generated a change in transport patterns. All these are essentially technology centred approaches that some commentators, for example Welford, (1996 and 1997) reject as inadequate. They contend that technological advances alone are insufficient to guarantee continued survival, and social reforms are also vital, as present trends are in no measure sustainable. Their position is analogous to Schumacher's observation that without radical restructuring of entire economic systems, any less intervention is 'rearranging deckchairs on the Titanic' (Schumacher, 1973).

A variety of theoretical approaches have emerged that enable industry to resolve environmental problems. These tend to be largely techno-centric, revolving around eco-efficiency measures and recycling that treat the environment in isolation. More advanced thinking questions this view and places greater emphasis on organisational changes. The ideas encompassed in eco-modernity are very persuasive for business. The reduction of waste, increasing energy and resource efficiency combine to improve economic performance, despite the risk that realising environmental and commercial objectives may involve compromises. The next section examines how commerce has integrated these ideas and reasserted them as part of a competitive strategy.

2.5 Environment and Competitiveness; Strategic Management.

2.5.1. Competitiveness and Modernity.

Important facets of eco-modernity include the theory of inter-firm competition and the literature on management, and in particular, environmental management. These systems provide businesses with vital management tools, as they permit a control of resources to maximise efficiency. Close monitoring and accountability of production can identify areas of weakness. This enables a firm to align with an environmental management standard as a means of gaining a competitive advantage, which is closely associated with environmental reporting. This has arisen from traditional accounting techniques (Gray et al. 1993), and has developed into what Elkington (1994) refers to as the 'triple bottom line', as businesses report on financial, environmental and social commitments.

Environmental Management Systems have emerged from Total Quality Management (TQM), which have been primarily developed for use in large firms (Glekman and Krut, 1997). It is useful to examine the evolution of these management systems and their relevance to SMEs.

2.5.2 Competitiveness and the Environment.

Welford (1996) summarised Meima's theoretical framework, which suggested there are several positions underlying environmental management strategies. First, there is a moral or ethical imperative. The second paradigm regards environmental quality as a function of a Total Quality approach. The third relates to the idea of competitive advantage arising from a proactive environmental strategy, and will be discussed in greater detail. The fourth approach, determining ways in which industrial action can be made compatible with nature, for example through minimising waste at source, is in accord with an eco-design philosophy. Other notable conceptual models include those by Steger (1993) and Roome (1994). Steger (1993) anticipates four business philosophies centred around the concept of risk; indifference, offensive, defensive and innovative.

An indifferent stance implies that a firm is exposed to low environmental risk, and has low environmentally based opportunities for growth. An offensive strategy is adopted by firms active in markets where there is potential to exploit environmentally related opportunities, for example, pollution abatement equipment. Defensive firms are involved in high-risk businesses, for example chemical companies, who cannot afford to ignore environmental issues. Innovators have a high environmental risk, and also considerable opportunity for environmentally based growth. A number of other models align firms on a continuum of management strategies, summarised by Hass (1996). These are variants on the categories devised by Roome (1992), that proposed five strategic stages:

- Non-compliance.
- Compliance.
- Compliance plus.
- Commercial and environmental.
- Leading edge.

This model suggests a progression between the five stages.

In contrast, Starik et al (1996) outlined a matrix based approach, centred around firm orientation and value creation, derived from the well known Ansoff Matrix (Ansoff, 1965). This model enables a firm to identify appropriate environmental actions. If it is driven by cost reductions, then pollution prevention is the optimum strategy. Conversely, a proactive organisation is better placed to innovate 'green' products.

Both types of model proposed by Steger and Starik are market oriented, driven by risk and opportunity. Linear models, such as Roome's, imply that firms need to be aware of their operating environment, so legislation, organisational change and other constraints becomes more dominant.

Figure 2.3. Environmental Strategic Postures
Value Creation Approach

		Benefit Enhancement	Cost Reduction
Change Orientation	Proactive	Green Product Innovation (Major modification)	Pollution prevention beyond compliance
	Accommodative	Green Product Differentiation (Minor modification)	Pollution prevention compliance

Source: Starik et al. (1996)

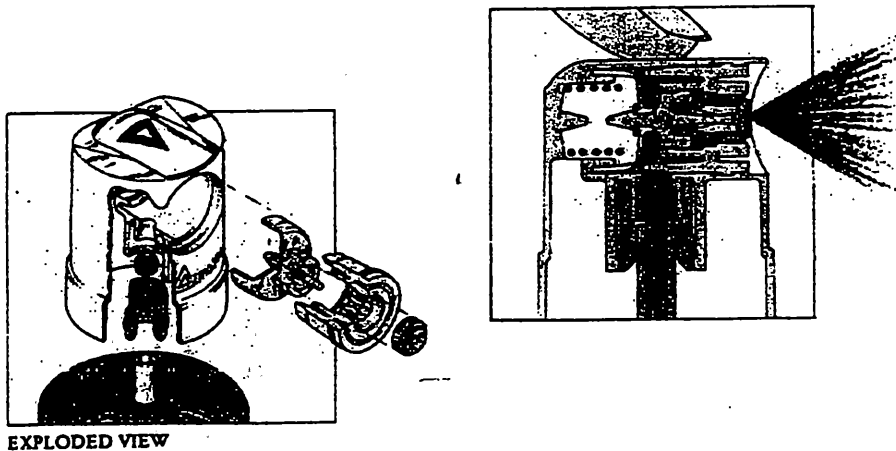
Alternative approaches, for example Bansal's (1993, in Welford, 1996) identify a range of activities which can be addressed simultaneously, allowing a firm to pursue 'green' marketing, environmental management and research and development options to achieve environmental improvements.

Hass (1996) criticises these models on the grounds that in practice, they are difficult to operationalise or are not robust. She argues that linear models do not provide a very useful research framework, are too narrowly focused on certain elements of environmental management, such as risk or audits, and do not reflect the overall business context. Another criticism is that environmental management models have been developed in isolation and do not integrate with the general business strategy of the firm. Poor integration may be because environmental issues are a comparatively recent phenomena, the benefits and costs of pursuing strategies beyond legislative compliance are uncertain. Technological solutions, with the exception of environmental technology, are largely unproven. Uncertainty of direction is an unfavourable operating condition for businesses, and SMEs in particular. In reality, Greeno (Various Authors, 1994) contends that although business would like to achieve excellence, in practice they really seek compliance, if only to avoid the rising costs of non-compliance.

In the typologies outlined, the evidence suggests that most SMEs are mainly reactive or non-compliant, or focused on cost reduction (Hillary, 2000). Hutchinson and Chaston (1994) claimed this is due to a lack of strategic management. Most SMEs are unable to move into 'green' product innovation, and are more likely to respond to compliance issues (ETBPP, 1996). While these models are of questionable relevance to the majority of SMEs, some firms are innovative, and able to exploit the competitive advantages offered by 'greening'. Some examples were investigated by Smith et al. (1996) in a study of some sixteen firms, and found smaller firms appeared to be more likely to adopt proactive strategies than larger enterprises. This can be illustrated with reference to the development of Atmosol, a novel approach to solving the problem of hazardous gases used as propellants in aerosols.

Figure 2.4 The Atmosol Aerosol System.

Atmosol is an aerosol system that enables alternative propellants, such as compressed nitrogen or carbon dioxide to replace conventional propellants. It was developed in the wake of the CFC ban, and to reduce the hazards associated with liquefied gas aerosols, such as butane. It also coincided with the US legislation to reduce the level of volatile organic compounds (VOCs) in aerosols by 30%. The design features an innovative regulator and ball valve.



The design promised competitive advantages over conventional systems, as the solution overcame regulatory pressure and safety issues, and could be used in a wide variety of applications.

The theme of competitive advantage delivered through process modification ('cleaner production') and new, innovative products is relevant to SMEs, and will be revisited later.

2.5.3. Strategic Corporate Responses to the Environment and competitiveness.

It can be argued that industry naturally adopts 'cleaner production' as a function of process and product evolution. Jackson (1994) provides a useful definition;

"An operational approach to the development of the system of production and consumption, which incorporates a preventative approach to environmental protection."

'Cleaner production' entails minimising the environmental effects of production and waste and pollution at source. The resultant increased efficiency theoretically confers a competitive advantage. The potential commercial benefits of embracing environmental issues following this process of self-improvement have been proposed by Porter and van der Linde (1995), who suggested;

"Pollution equals a manifestation of economic waste".

In their view, pollution and incomplete utilisation of resources imply inefficiency. They argued that industry has traditionally regarded environmental issues as a trade off between private costs and social benefits. The new paradigm of international competitiveness implies a new dynamic, based on innovation. At the industry level, they believed superior productivity could be delivered through reduced costs, or products with superior performance justified a price premium. Although they favoured the ability of markets to deliver environmental benefits, they also recognised its limitations. Prior to regulation that imposed financial penalties, it was often cheaper to pollute than reduce waste. Firms do not operate in static, perfect conditions, or are able to make 'optimal choices'. They are in dynamic competition, have limited access to information and have organisational inertia, reflected in the difficulties in aligning individuals, groups and corporate incentives.

The authors contended;

Companies have numerous avenues for technological improvement, and limited attention."

The implications are that markets need properly designed environmental standards designed to regulate market imperfections and stimulate innovation. However, Porter and van der Linde (ibid) also recognised that environmental issues are new to many companies, and it has not been an area of corporate or technological emphasis, where in many industries knowledge is rudimentary and there is considerable uncertainty about the benefits of innovation. There has been considerable debate about the merits of regulation as a driver for innovation and competitiveness. Schmidheiny (1992) supported the contention that self-regulation by industry is the favoured approach, while Cairncross (1994) argued that increased competitiveness cannot be delivered through standards. Green et al. (1994) found that regulation was claimed to stimulate innovation in products and processes, and Wong and Stoneman (1995) proposed that further regulation may be needed to encourage the diffusion of environmentally friendly goods. Garrod and Chadwick (1996) were unable to detect an underlying change in culture above a 'green gloss', and contended that a paradigm shift requires a legislative push, as opposed to the voluntary context favoured by other commentators. Other authors, notably Welford (1997) support the argument that current business practices are incompatible with the aims of sustainable development, and more radical solutions other than market forces will be required.

Inter-firm competitiveness tied to eco-modernity mark a new direction for business. Environmental issues have been reinvented as opportunities as opposed to threats by pro-active, strategically aware firms. There is a wave of concern that is shaping businesses, but how it is working through to SMEs is still unclear.

2.6 Industrial Transformation and the Resurgence of SMEs.

2.6.1. The New Industrial Revolution.

The transformation of industry can be summarised as the shift from craft based industries of the early industrial revolution, through the introduction of mass production techniques epitomised by 'Fordism' at the turn of the 20th century, to 'lean' production concepts embodied in the 1960s. Transformation is also characterised by the shift towards service based economies in the developed world and the restructuring of large firms, including a decline in the number of very large firms (Storey, 1994), and expansion of the number of very small, or 'micro' scale enterprises. The service sector is projected to expand while manufacturing contracts. This is very significant for the future of smaller firms, because seven out of ten SMEs are services (Blackburn, 1996).

Prior to the advent of the industrial revolution, products were generally unique designs, or short runs of a similar pattern, with little need for conformity or standardisation. Production was typically on an individual or local scale, often carried out in the homes of people who used simple tools and machinery, with little division of labour. The industrial revolution from around 1750 provided the impetus for the growth of craft based industries. This system was ultimately destroyed by a series of inventions in the textile, iron and engineering industries that transformed the techniques and economic organisation of every sector of industry (Harrison, 1975). The introduction of Fordist, or 'mass production' techniques from the turn of the 20th Century created conditions where products could be replicated to ensure conformity and increase productivity levels, as workers focused on localised aspects of production, such as assembly. 'Taylorist' management principles were developed to measure and regulate productivity. The introduction of 'lean production' during the 1960s through Japanese styles of management further refined mass production, while offering the flexibility of craft production with the low costs of mass production. Such changes included Total Quality Management (TQM) and 'Just in Time' (JIT) systems (Wallace, 1996). JIT had the effect of increasing productivity still further, through improved efficiency, reduced waste, inventories and production time.

This process has been epitomised in the transformation of the Motor industry (Womack et al, 1990). Since the industrial revolution, the general trend has been towards ever larger firms, increasing levels of global trade with massive social and economic implications. These changes have swept through virtually every country, leaving a radically altered post-industrial landscape. Some of the models that attempt to analyse principle components of industrial, economic and social developments are summarised in Table 2.2.

Table 2.2. Models of a Post-Fordist Economy.

<i>Loveman and Sengenberger (1990) 'Large Scale, Mass Production'.</i>	<i>Curran and Blackburn (1990) 'Post-Fordist'.</i>	<i>Piore and Sabel, (1984) 'Flexible Specialisation'.</i>
<ul style="list-style-type: none"> • Mass production of standardised products, built using specific capital equipment and technology, • Mass expansion to minimise cost and to assure the absorption of the output of mass produced commodities, • Keynesian-type demand management policies and income stabilisation to ensure continuous mass purchasing power. 	<ul style="list-style-type: none"> • Fordist, mass production, • Vertical disintegration of large firms • Flexible firms, where small firms are confined to a subcontractor role serving the needs of large firms, • Flexible specialisation, where small firms have some control over the labour process, the products and the markets in which they operate. 	<ul style="list-style-type: none"> • New flexible manufacturing technology • A renewed craft tradition which provides workers with some autonomy over decision making processes, • The break up of mass markets, and the resurgence of regional economies.

The Loveman and Sengenberger (1990) model of industrialisation embraces western market and centralised, planned economies typified by Central and Eastern Europe, and some developing countries. The authors stressed the importance of a 'Taylorist' style work organisation, utilising highly differentiated labour, and narrowly defined jobs that required little training. In this scenario, the planning and execution of work is separated, with an extensive hierarchical and managerial bureaucracy, and complete lack of awareness of the contribution of SMEs.

They also revealed that as enterprises were expanding, capital ownership was becoming continually more concentrated. Today, Multinational enterprises (MNEs) control and own most of the world's technology, and around 80% of global Research and Development (R &D) activities can be found in firms with more than 10,000 employees (Eden et al, 1997). Collins and Porras (1994) investigated the characteristics of super-successful industries, and implicitly support the growth of multi-national enterprises. Wallace (1996) proposed that the global presence of MNEs and their control of resources could be deployed more equitably and rapidly than individual nation states. Other authors, notably Korten (1995) and Schumacher (1973) warned that the dominance of large scale industries and the consequent globalisation of trade would lead to environmental and social collapse. This would arise because of the global inequalities of resource production and consumption by multinational corporations whose power eclipses that of individual national governments, although this proposition is contested by Archibugi and Michie (1997). Both Piore and Sabel (1984) and Curran and Blackburn (1990) proposed that a restructured, post-Fordist economy would be a more complex industrial mix of large and small firms, where large firms would delegate some control of production processes through a sub-contracting relationship with smaller firms. There is also emphasises on the resurgence of craft traditions, including the practice of 'flexible specialisation' that could benefit SMEs in regional markets in a largely post-Fordist market based model of industrial production. Storey (1994) observes that interest in 'flexible specialisation' is declining, as there is little evidence to suggest the idea survived and spread beyond a limited area of Italy. There is also the recognition of the growing importance of the service sector in the developed world, coupled with the shift from the 'push' supply driven Fordist paradigm to the market driven values of Lean Production. Manufacturers have responded more closely to customer demands, and the exchange of information as a tradable commodity has become an important factor (Toffler, 1980).

2.6.2. Small Firms in a Post-Industrial Society.

There is a renewed interest in the contribution SMEs have to a restructured, more environmentally sensitive, post-Fordist economy. UK Advisory Council on Science and Technology (ACOST) recognised the significant contribution of small firms to the economy, concluding that;

“Smaller firms (<500 employees) play a vital role in the translation of new scientific and technological knowledge into economic wealth. It is from these companies that we expect some of the major international businesses of the future to emerge.”

ACOST (1990).

This paraphrases Schumpeter's (1934) process of *creative destruction*, whereby the continual creation of new ideas by innovative firms steadily destroys the positions of stagnant firms. The UK government desires a dynamic small business sector, where some of the small businesses of today will eventually dominate new markets. The role of small firms is changing, and in many economies SMEs make up the largest share, by number of most industrial sectors (Geiser and Crul, 1996). Storey (1994) contributed a very thorough review of the changing role of SMEs in the economy. One of the many observations made was that the role of the manufacturing sector has declined. In the general restructuring of industry, the number of very large manufacturing firms has decreased, particularly in the UK. Employment in manufacturing has declined from 34% to 20% of the labour market between the 1970s to 1994, (Hillary, 1995). This process coincided with the emergence and expansion of new, high technology based services which now provide in excess of 70% of employment in the USA (Allenby, 1998). Interest in small firms has grown for a variety of reasons, and according to Blackburn (1996);

“Governments have also expressed an interest in the role of smaller firms, as a means of economic growth, job creation, innovation, flexibility and a route to self-expression by the labour force.”

Concern for the economic performance of the small business sector has led to the implementation of a range of policies designed to create favourable conditions. Rothwell and Zegveld (1982) and Schmidheiny (1992) argue that SMEs deserve general policy support for a number of reasons, summarised in Table 2.3.

Table 2.3. Policy Reasons for Supporting SMEs

<i>Rothwell and Zegveld (1982)</i>	<i>Schmidheiny (1992)</i>
They provide social and political stability by preventing the over-concentration of commercial power,	Organising mutual support and information exchange networks
They prevent the misallocation of resources arising from monopolies or oligopolies, which can generate inefficiencies and complacency, thus guaranteeing some market dynamism,	Pressurising government agencies to ease access to venture capital, and provide grants for access to information;
They provide a diversity of products	Gain access to expertise required for technical assessment and negotiations
They can be a buffer in a fluctuating employment market	They are vital 'innovation engines' and constitute a resource from which large firms can draw to maximise their 'technological co-operation'

It is apparent that SMEs are politically, socially and economically important. The sector is viewed as fundamental to the economic development of the European Union (EU), with particular encouragement given to 'entrepreneurial' SMEs (Bangemann, 1994). The European Consultative Forum on the Environment and Sustainable Development (ECFESD) has considered policy options that combine environmental issues with employment creation (ECFESD, 1998). The environmental performance of SMEs has also been linked with the long-term competitiveness of industry (EIM, 1997). The European Environment Agency (EEA) has contributed political visions of the role of SMEs expressed in the Fifth Framework Programme "Inventing Tomorrow" (Andersson, 1997). This report identified sustainable development, market opportunities and job creation as important challenges for SMEs, which are also encouraged to become more eco-efficient'. The European Commission is anxious to encourage greater participation of innovative SMEs in research programmes, and

to improve the transfer of innovations to market exploitation. The intention is to devote further resources and rationalise and co-ordinate information networks, particularly in the field of best practice of technology transfer and innovation policy.

SMEs perform an important social and economic function, in particular their capacity for preventing the over-concentration of economic power in favour of large enterprises. They also play a distinctive role as 'innovation engines', supplying a rich diversity of products and services. It is this predominant role as sources of innovation that will be examined in greater depth. Given the political will to provide support for smaller firms, it is useful to inspect some aspects of their nature, entrepreneurial motivation, prospects for growth and survival, and the pressures they face.

2.6.3. The Creation, Survival and Growth of SMEs.

The authoritative work on small firms by Storey (1994) outlined the complex nature of the conditions that govern the establishment of small firms, their survival, contribution to job creation and the economy and productivity compared to large firms. The great majority of small firms are self-employed, single person enterprises, or 'Owner Managers'. In England and Wales, some 400,000 new businesses are started each year, and a similar number close or change ownership. The great majority show little change in either turnover or employment (DTI, 1996a). What is important is that government statistics show more than 60% of all new small firms fail within the first five years (DTI, *ibid*), mainly due to lack of management experience or training, inability to respond to changing market needs and failure to delegate. It is estimated that 2/3 of closures were avoidable, while failure due to insolvency accounted for only 27% of firms. A study of new businesses (DTI, *ibid*) indicated that after three years, a few firms exhibited rapid growth, almost a quarter were stable or declined, and the majority achieved more modest growth. The prospects are good for those firms which do survive beyond the crucial 'start up phase' of the first four years, for whom the chances of persisting for ten years are almost 50% (Curran, 1986). More recently, McGie (1999) reported on a study that showed that the failure rate in firms more than six years old fell to around 11%.

The creation of small businesses has been intensively studied but their subsequent prospects for growth remains unclear. Barkham et al. (1996) emphasised the political and commercial importance for both national and regional economies.

There are some significant qualitative differences between the 'trundlers' or growth averse firms, and the more proactive, growth oriented firms. Atkinson and Meager (1994) theorised a four stage, managerial approach to enterprise development that proposed four thresholds encountered during the process of growth. These are described as;

1. An entry threshold- the decision to take on the first worker
2. Delegation threshold- the employment of the first manager
3. Formalisation threshold- the movement away from *ad hoc* recruitment of labour and more structured management systems
4. Functional threshold- employment of a personnel or recruitment specialist.

Adapted from Atkinson and Meager (1994)

A further important distinction is to be made between 'micro' scale enterprises, comprising the owner manager, or sole trader, and businesses that seek growth. The prime motivation behind the former style of business is independence, and growth would entail a loss of control, exposure to external influences and other organisational problems. Conversely, growth oriented or expansionist firms are more likely to create links with other organisations and be responsive to external assistance, such as initiatives designed to encourage business expansion (Gray, 1995; Storey, 1994).

These are also the firms more likely to provide potential for stable, long term employment and overall positive contribution to the economy. The initial starting conditions of a small firm may also be important for determining long term prosperity. Tiler et al (1993) proposed three distinct business strategies, based on a study of technology-based companies. In summary, these are;

1. The 'soft' start company. This type involves utilising existing contracts to supply consultancy or contract development work on a bespoke basis, utilising the highly specialised skills of the founder(s). Technical excellence and specialisation avoids the need for well-developed marketing.

2. The 'hard' start. In contrast to the soft start firms, these firms need more up-front investment in Research and Development (R & D) before any orders have been received. Future development depends on the scale of start-up, and are exposed to greater risk than 'soft' start firms
3. The 'transitional' start. Involves the use of a soft start as a preliminary step to moving towards a more product-oriented strategy, and many 'soft' start firms undergo these changes as new market opportunities emerge. These firms are concerned with undertaking R & D contracts on behalf of customers, and using these contracts as the basis for further products.

The researchers concluded that further growth in such firms required considerable adjustments, or transitions. These included organisational changes, incurring the introduction of management structures. Firms needed to expand their product base from customised or batch, to mass production, or from a single to multiple product company. They also needed to acquire marketing skills to operate in high volume or export markets. (Acs et al. 1997) Dodgson and Rothwell (1989) also identified a series of transitions, from start up, technological consolidation, internalisation of markets, professionalisation of management, vertical integration and eventual product and business diversification. The authors observed that the managerial transition was often a traumatic period for the founder, as they found it difficult to share control. Some small business managers also believe coping with strategic decisions is among the key skills needed to cope with such transitions (Financial times, 1996).

Storey (1994) summarised the main factors that influence the growth prospects of a firm; the background and resources of the entrepreneur, the nature of the firm and the strategic decisions taken by the owner-managers. He concluded that it is extremely difficult to predict the success of a firm at start-up. Some characteristics of firms that do survive include those that are capable of innovation, either through introducing new products or adding to existing product lines, are able to adjust to changing market conditions, and have a diverse customer base. Weston (1996) also noted the importance of a network of collaborative relationships. Failed businesses tend to exhibit a high rate of staff turnover, are associated with relatively unstable, low quality jobs and poor training programmes. Conditions that are favourable to SMEs include a stable macro-economic climate, measures to create a long-term increase in the competence of the workforce and an infrastructure in which smaller firms can pool resources and learning from each other.

It should not be assumed that a tightly defined prescription can be applied to all firms as a palliative for unemployment. Curran (1986) observed that most small firm owners opt for a 'steady state' business, possibly because growth could undermine their independence and autonomy, and expose them to management problems, for which they are poorly prepared. Gray (1995) also made this observation about entrepreneurship and growth in small firms;

"The complexity of motivational issues in management behaviour and business development certainly refutes the notion that small business growth can be explained on the basis of a single profit-maximisation motive or that public policy can call up entrepreneurial behaviour on demand".

Rapidly expanding firms are the converse of 'trundlers' or growth averse firms, and have inevitably attracted considerable policy attention, and analysed comprehensively in Storey's authoritative work (1994). From a calculation based on empirical data, he inferred that only around 4% of businesses which start today will, ten years later, provide nearly 50% of employment in surviving firms. Considerable government resources have been dedicated to the promotion and support of new businesses, including training and finance. Mason et al. (1988) noted that in contrast, very little attention has been given to providing long-term financial support enabling businesses to expand. All these issues were summarised by ACOST (1990);

"The most important of these (barriers to growth) relate to the problems of remaining competitive as markets grow and mature, and managing the major transitions required to exploit new business opportunities."

The barriers that prevent organisational changes are largely internal, and depend on the vision and attitudes towards risk in the firm (Acs et al. 1997). External barriers may be involved if human resources are a limiting factor (Gray, 1995). The barriers to expanding product base and markets are a combination of internal and external influences, organisational, economic and technological (Acs et al. 1997; Curran, 1986).

Within high technology firms, Tiler et al (1993) concluded that public policies designed to promote entrepreneurship were most effective if they addressed the external barriers. The Confederation of British Industry (CBI, 1996) identified the promotion of entrepreneurship as a key policy objective, but recognised that growing firms inevitably experienced significant problems in undergoing transitions in management and ownership structures. There has been much research devoted to identifying the principle features of successful, dynamic, highly growth oriented enterprises for obvious commercial and political reasons. This brief overview indicates that there are a complex range of factors that determine survival and growth, from internal characteristics through external trading conditions. Very few firms are likely to experience exponential rates of growth, or will survive and prosper beyond the early hazardous developmental phases.

2.6.4. Concluding Remarks.

Growth oriented firms constitute a tiny minority of all SMEs, but are important because of their long term contribution to the economy and employment. They contrast with the 'micro firms' (fewer than 10 employees), estimated at some 93% of all firms within the EU (Gray, 1996b). Expanding firms also have inherently different characteristics from other firms, particularly in origin, motivation, aspirations, and survival prospects. Certain *types* of SMEs have potential for continued expansion, and may be identified by a complex and interrelated set of attitudes, motivations and origins. These firms may be more responsive to training initiatives that could help them integrate environmental decision making into general strategic business development.

There has been considerable research devoted to the study of small businesses, in particular those worthy of investment for social and commercial reasons. It is a complex picture, however, and difficult to predict businesses that will flourish from promising starting conditions. It is also a gross oversimplification to regard the SME community as homogenous. Most SMEs are growth averse, 'micro' scale owner-managers, where the main motive for going into business is to gain independence.

Some SMEs have expansionist ambitions and of these a small fraction are capable of exploiting new, innovative, potentially environmentally friendly technologies and markets. This is an important area for research, and is the reason to concentrate on this type of SMEs.

2.7 Industrial Transformation, the 'Greening' of Industry and the role of Small Firms

2.7.1 Introduction.

This section discusses the attitudes prevalent in SMEs towards environmental issues, and their degree of action. Their behaviour is largely framed by environmental regulation, which in this context includes industrial standards. These can be regarded as 'sticks' that push enterprises towards more environmentally benign practices. Conversely, there are also schemes designed to encourage and stimulate interest in such activities. These 'carrots' have mainly focused on process and energy efficiency measures combined with waste reduction or resource efficiency. Attention has recently shifted towards addressing products through the promotion of 'environmental' goods and services. The section concludes with a summary of the effectiveness of environmental support provided to SMEs in the UK.

2.7.2. The SME Response to Environmental Issues; Rhetoric and Reality.

Some industrial sectors, including chemicals, steel and transportation equipment are dominated by large-scale enterprises, and effective regulation of such industries could produce significant environmental benefits. This is why much of the environmental regulation to date has focused attention on such high profile industries. Given the wide geographical spread of SMEs, their contribution to the overall environmental loading is amplified (Geiser and Crul, 1996). It has been estimated that SMEs account for 70% of industrial pollution (Hillary, 1995), and that the most polluting SMEs are small firms employing 20-25 people (Ribó, 1995).

One survey estimated that SMEs account for over 50% of Dutch national industrial emissions of ozone depleting substances and wastes for disposal, and around 25% of emissions of acid gases and hazardous substances, including volatile organic compounds (VOCs) (ENDS 267, 1997). Since the data for pollution attributable to SMEs is difficult to assess accurately, and most SMEs are service oriented this figure has dubious validity. There is little doubt that the overall contribution to emissions from the SME sector are important, and may be locally very significant. By reducing their environmental impact there is significant scope for improving the environmental performance of industry, through innovations in products, processes or services.

2.7.3. SME Attitudes to Environmental Issues.

Environmental issues are gradually permeating through large businesses, but the SME community appears to be very reactionary. Various studies (Galapagos Management Consultancy, 1993; Hutchinson and Chaston, 1994; Hillary, 1995; Holt et al, 1998; Spence et al. 1998) have shown that most SMEs are simply ignorant of their legal obligations with respect to current environmental legislation, and voluntary standards which are widely accepted practices in larger businesses. This may help to explain why so SMEs are responsible for much industrial pollution. Much of the research suggest few SMEs are aware of mandatory environmental legislation, including the Environmental Protection Act (EPA) (1990), the Water Act (1989), Control of Substances Hazardous to Health (COSHH) or Duty of Care regulations. The reasons for this are suggested by Hillary (1995) who found that most SMEs are faced with more pressing issues, including tax laws, VAT and employment legislation, which are more rigorously enforced than environmental regulations. This attitude appears to be changing. The Groundwork Trust (1998) indicated that SMEs now consider the environment to be an important business issue, and regulation is an increasingly important driver. For them, it ranks ahead of statutory requirements, investment, exchange rate, exports, European single currency and credit control. In general, SMEs are laggards in relation to mandatory environmental legislation and most SMEs are ignorant of their environmental liability. Petts et al. (1999) suggest this is due to a mismatch of regulatory climate and small business culture rather than deliberate non-compliance.

Many SMEs still regard the environment to be peripheral to their business practices, and management strategies, if present, tend to be geared towards immediate, critical incidents. Investment in long term, unquantifiable or intangible benefits receive little attention (IIIIEE, 1997).

2.7.4. Reality; Current practices.

Environmental issues are gradually influencing the way in which large businesses operate, chiefly in the guise of management practices, and formalised in environmental management systems (EMS). In SMEs, awareness and use of environmental standards, or voluntary codes of practice, is unsurprisingly low. Hutchinson and Chaston (1994) reported that more than 2/3 of firms surveyed was unaware of the Environmental Management Standard, BS 7750. Even fewer firms undertook environmental audits, or had produced environmental policies. Where firms had responded to environmental issues, it was through energy and waste management schemes, which suggests that firms are more likely to exploit immediate benefits achieved through cost savings and compliance. In contrast, both Citron (1993) and Gray (1996a) found that most SMEs interviewed knew about Total Quality Management (TQM) standards (BS 5750 and ISO 9000), and newer and larger small firms were more likely to have some appreciation of the environmental impacts of their activities. Manufacturers and exporters were also more responsive to supply chain pressure. Gray (1996a) also observed that such firms were also growth oriented, and they perceived that their own performance was strongly associated with the performance of larger firms. The effects of these quality standards, notably ISO9000, included improved internal management, efficiency gains, marketing advantages through the use of an approved logo and enhanced reputation.

Most SMEs have failed to incorporate environmental issues into general management decisions. Ironically, according to Hutchinson and Chaston (1994), most small firms believe environmental issues will become more important in the future, and are unlikely to diminish. Local environmental issues, such as air and water pollution tend to be considered more important than long-term concerns.

Awareness of environmental issues tends to be low and knowledge is confused. SMEs are also typically operationally oriented, and strategic management of any sort is rare in SMEs. They are more likely to respond to changes in operation or process, and unwilling to contemplate investment in capital. There are some important qualitative differences between different types of SMEs. Larger, manufacturing and export oriented firms are more aware of environmental issues than their smaller, service based counterparts. Most SMEs are reactive to environmental issues including legislation and management systems, and they are presented with barriers to implementing changes. These include the expense of adopting potentially ill-suited management standards, lack of relevant, carefully directed information and perception of the potential problems. SMEs are reluctant to adopt any strategy where the risks are poorly understood, information and assistance unfocused or non-specific, or support services do not match their needs.

The Groundwork Trust (1998) commented that SMEs are facing increasing demands from consumers, banks and their business partners to improve their environmental performance. SMEs are typically poorly informed and reactive but potentially concerned about their environmental obligations. In recognition of this complex problem there have been a host of initiatives and policies launched to improve the SME sector. These include appropriate and relevant assistance for training, management systems and information (Andersson, 1997; Hutchinson and Chaston, 1994) but there is considerable uncertainty about which is most appropriate for their needs. Some of the many agencies and policies will be discussed more fully in the next section.

2.8 Policies for Transforming SME Environmental Performance.

2.8.1. Introduction.

UK Government and the EU have introduced initiatives to help SMEs become more environmentally aware. These are a mixture of regulations, financial incentives and the provision of information. The focus has been largely geared to assisting manufacturing firms through the diffusion of 'best practice' projects that communicate the financial benefits of resource and energy efficiency and waste

minimisation. The framework of policies designed to improve environmental performance can be classified using a hierarchy, graduating from mandatory or compulsory compliance through to information based approaches. This hierarchy also matches the shift from process oriented regulations, or command and control style policies, through to more market based product level measures and incentives. Some of these policy instruments are shown in Table 2.4.

Table 2.4. SMEs and the Environment Policy Framework for UK Firms.

Policy Level	Level of Effect		
	Process	Product/Service	Sector specific/general
(Mandatory)	Regulations based on Health and Safety issues, other end-of-pipe measures, including discharge consents, duty of care, IPPC	N/A	Compliance is an issue in SMEs
Statutory Obligations		H & S related regulation, specific to electrical equipment, CE approval	All products require certification
Packaging/Recycling	Yes	Proposed EU 'Take back' legislation	General. Initially packaging has been targeted. Proposals will affect specific product groups
Standards (increasingly mandatory)	ISO9000 initially, now may include ISO14001	Optional part of ISO 14001; LCA	General, aimed at manufacturing, but will influence many firms, particularly as a supply chain issue.
EMS	ISO14001	ISO14001 includes optional product evaluation; Design for the Environment (DfE)	Affects product & service providers <i>Table continued over</i>

(Table 2.4 continued)

Policy Level	Level of Effect		
Information and help lines; Waste Minimisation Clubs, Energy Efficiency and Cleaner Technology	Yes	N/A	Aimed at manufacturing firms.
Other Information designed to promote 'best practice', including environmental reporting.	Process	Product/Service	Sector specific/general
	e.g. ACCA awards (ACCA, 1997)	Possibly both	Sector specific guides, for example the Rural Development Commission's 'Green Audit Pack', aimed at the tourist industry. (RDC, 1996)
Product Labelling/other award schemes	No, unless based on LCA	Eco-labelling, and schemes including RSA 'green products'; Other independent schemes, e.g. RIBA 'Green building' award	Some schemes operated by particular industry sectors (e.g. RIBA). UK SMEs absent from formal EU Eco-label
Eco-Design (Voluntary)	Yes	Yes	Various techniques and manuals available, including ecological footprints that combine most of the preceding aspects, and permit system level analysis. Infrequently used in SMEs

In essence, intervention range from mandatory compliance with regulations, including industrial standards, through to information based incentive schemes designed to encourage greater environmental responsibility. The main driver has been the introduction of supply side environmental legislation. In contrast, there has been little attention paid to encouraging product innovation. Market based incentives aimed at stimulating demand for 'green' products or services have been limited to providing consumers with information about the environmental profile of selected product groups through various energy and eco-labelling programmes. Research in this area is limited, however Smith et al (1996) reviewed the commercial performance and competitive advantages of 16 'green' products.

Some surveys of consumer behaviour claim environmental issues are rising in importance up the corporate agenda. They should be treated with caution, as the nature of the questions asked can present extremely misleading conclusions (Moffatt Associates Partnership, 1996). Other surveys of consumer attitudes purported to show that consumers are theoretically not only more aware of environmental issues, but are also willing to sacrifice performance or accept a price penalty (Intel, 1991 and 1994). In general such beliefs do not appear to have translated into practice, except in the ethical or environmental investment markets, (Stott, 1996). Such surveys serve to illustrate the gap between belief and action, both at a consumer and business level. This is important as it shows that consumers are expecting high environmental performance, but businesses, and SMEs in particular are generally failing to respond.

SMEs are not very environmentally sensitive. This is increasingly putting them at a competitive disadvantage. There are several policy approaches that can rectify this position, including stimulating markets for environmentally friendly practices and products, and can be considered either 'sticks' or 'carrots'. The former includes regulation and standards, which serve to increase compliance. The latter are more market based, such as communicating the business benefits of process efficiency, environmental communications and product labelling schemes

2.8.2. Environmental Regulation and Industrial Standards.

The amount and scope of environmental regulation has been increasing since the early 1970s, and by 1987 the EU had applied nearly 200 command and control Directives (Welford, 1996), aimed at limiting or prescribing certain industrial processes. Historically, legislation has been directed at the control of industrial processes. The EU intends to broaden the approach to include products through other directives designed to divert waste material away from landfill sites. It is proposed that this objective can be achieved through packaging ordinances and recycling targets, aimed at reducing the waste stream. The European Commission (EC) is also threatening to introduce other product centred legislation that will require manufacturers to take responsibility for the recovery and recycling of their products, and will initially affect companies in the electronics and automotive industries (ENDS 283, 1998; McLaren et al. 1997).

Industrial standards are also affecting businesses. These are primarily the quality standards, including the British Standard 5750 (BS 5750) and the International Organisation for Standardisation 9000 series (ISO 9000), also known as Total Quality Management (TQM). In many industries voluntary Quality initiatives are now broadly recognised, particularly in the manufacturing sector (Gray, 1996a). The original role of these standards was to ensure reliability and quality, and have formed the basis of Environmental Management Systems, presented through the ISO 14000 series of standards, and defined as;

"The organisational structure, responsibilities, practices, procedures, processes and resources for determining and implementing environmental policy."

BSI (1994).

EMS rapidly diffused through many sectors, notably engineering, as mechanisms for ensuring the adherence of minimum standards. It is becoming more important that companies comply with the requirements of the standards to maintain existing contracts, attract new clients or maintain a competitive advantage. In a study of the effects on design and competitiveness, Temple (1997) found that when product development coincided with quality certification, this increased productivity and profits. Singly, the effect was much weaker. Some organisations, including the public sector, are already demanding compliance with standards, such as ISO 14001 (New et al. 1998; ENDS 279, 1998b). Standards are also clearly becoming an important factor in inter-firm competition. The role of ISO9000, and its influence on ensuring supply chain quality should not be underestimated. The application of management systems have also received considerable attention from academic studies that embrace environmental reporting, accounting and general business realignment (Hutchinson and Hutchinson, 1997; Stead and Stead, 1996; Welford, 1996). They remain largely theoretical and little attention has been given to small firms or product innovation strategies from an environmental perspective. SMEs face a number of barriers to introducing some of these practices, most notably access to capital, information, and skills for assessing technological alternatives and negotiating arrangements (Schmidheiny, 1992). There are also managerial, financial and technical impediments that prevent SMEs from adopting environmental initiatives.

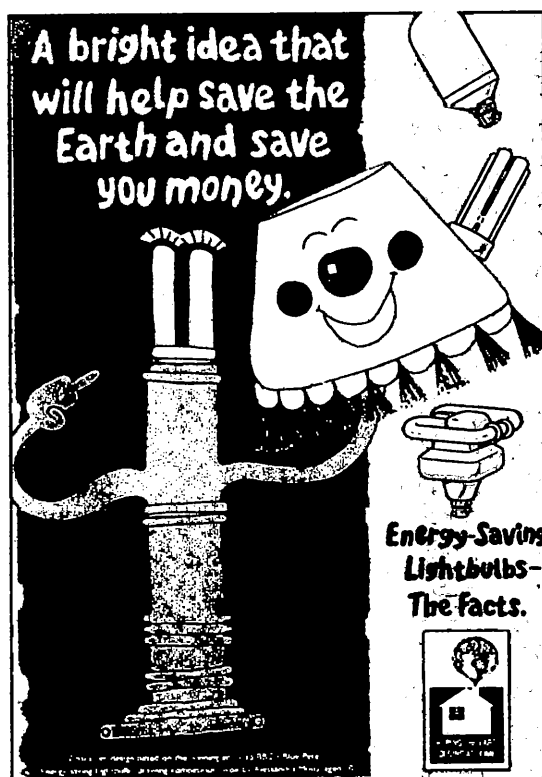
Although ISO14001 was originally targeted at manufacturing industries, it is starting to affect service based firms through the practice of environmental reporting. For example the UK Government's Advisory Committee on Business and the Environment (ACBE) published a 'Good Practice' guide for the Financial Services sector, which largely focuses on the financial implications of risk exposure and stakeholder interests (ACBE, 1997). In a similar vein, the Confederation of British Industry (CBI) launched a revised Environment Business Forum (EBF) as a demonstration of the potential for voluntary initiatives by business. This included a company self-assessment questionnaire to establish a 'benchmark' performance (ENDS 272, 1997). None of these initiatives have been constructed specifically for application in SMEs.

2.8.3. Incentives.

In contrast to regulatory and standards pressure on firms to adopt good environmental practices, various voluntary initiatives have been introduced that encourage SMEs to go 'green'. These have been a combination of the provision of information, supplemented with financial assistance. The underlying motivation has been material that focused largely on the diffusion of eco-efficient ideas based on a combination of cost reduction and management techniques. This eco-efficiency approach encourages firms to provide customers with the same products and services at lower environmental cost. A good example was the UK Government initiative designed to raise public awareness of energy efficiency through low energy lighting, illustrated in Figure 2.5.

UK Government initiatives aimed at improving the environmental performance of smaller enterprises has tended to focus on maximising resource and process efficiency, and the introduction of new, 'cleaner' technologies.

Figure 2.5. The Promotion of Low Energy Lighting.



Source: Department of Environment (1993).

The basis of these schemes is to diffuse ‘best practice’ through the dissemination of information, and to demonstrate the arguments in support of pollution abatement, resource and energy efficiency, and waste reduction. These include the establishment of waste minimisation clubs, managed by the Environmental Technology Best Practice Programme (ETBPP), the Small Company Environment and Management Assistance Scheme (SCEEMAS), ‘cleaner technology’ and energy efficiency campaigns. They run in tandem with the Energy Efficiency Best Practice projects. SCEEMAS offered grants to small firms to enable them to register with the EC’s eco-management and auditing scheme (EMAS). This attempted to encourage small firms to recognise the commercial advantages gained from a review of their environmental effects, produce an audit and develop a management system. In addition to these efforts at improving energy and resource efficiency, a network of waste minimisation clubs has been established and widely publicised (For example, see ENDS 270, 1997; ETBPP, 1997).

Commencing with the Aire and Calder and 'Catalyst' projects, they now number some 40 regional clubs involving over 400 firms. In a further development, a scheme in the Severn region aims to request that participating firms encourage their supply chains to join, thus spreading the impact of waste minimisation through the region (CEST, 1998; WS Atkins et al, 1994; ENDS, 265, 1997). Overall, of some 540 waste reduction opportunities identified by 11 different firms, 70% had a return on investment of less than one year, and annualised savings of £4 million (Cleaver, 1998).

2.8.4. Production Process Refinement and Product Innovation.

It is apparent that most of the aid and experience available is designed to help firms address largely process oriented improvements. In contrast there is comparatively little to help firms develop and promote environmentally friendly goods and services. The UK Government product oriented programmes present consumers with information about the environmental profile of selected product groups. These schemes include mandatory energy labels for white goods (CEC, 1995) and the voluntary EC 'Eco-Labeling' scheme (CEC, 1992). From a small business perspective, product labelling is virtually irrelevant, as it mainly affects large business interests. Interest in product labelling schemes in the UK has been limited (Smith and Potter, 1996; ENDS, 274 1997), and will be discussed further in the review of this section. Other schemes have been created to promote 'green' commodities and practices. These include the Royal Society for Arts (RSA) 'Green Product', and later the Queens Award for Environmental Achievement (DTI, 1996b). In spite of these attempts to promote 'green' products, successfully marketed commodities are rare, but few resources have been devoted to product oriented schemes.

2.8.5. Environmentally-Beneficial Goods and Services.

It is notable that the UK government has recently identified weaknesses in environmental policies. The view that is emerging is that traditional 'command and control' edicts are inappropriate instruments to stimulate the innovation and diffusion of 'green' technologies and products.

In 1997, the then DoE published a discussion paper on the 'Wider Costs and Benefits of Environmental Policy' (DoE, 1997), which stated;

"The market opportunities for suppliers of environmentally-beneficial goods and services tend ... to be left out of the equation. This is a relatively new and fragmented industry, with generally less established trade associations and Government sponsorship arrangements than its customer companies."

In addition, The UK Advisory Committee on Business and the Environment (ACBE) effectively reiterated support for the World Council for Sustainable Business (WCSB) focused on eco-efficiency (ACBE, 1998). The report reinforced the opinion expressed in the DoE (1997) paper, and hinted at some of the barriers that will be explored in this research when it commented on innovation and technology;

"For some sectors, take up of new technology is held back by lack of proven performance in a full production mode and the commercial risks of new technology. Other factors included company culture, lack of markets for newer, renewable technologies etc."

ACBE (1998).

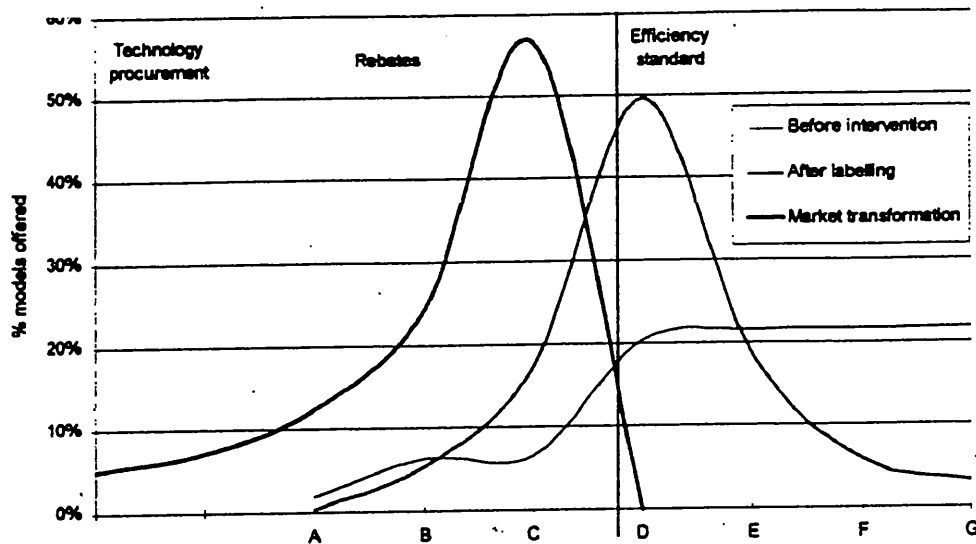
The UK government policy approach has been the introduction of broad ranging, 'market transformation' approach. This is defined as;

"It seeks to deliver better goods and services to more people, at lower cost and lower environmental impacts; improving the performance of the best products, while leaving no place for the poorest performers."

DETR (1999a).

The introduction of the 'Market Transformation Programme' operated by DETR aims to collaborate with, and encourage industry to achieve this policy objective. The policy instruments range from advisory material on energy efficiency and waste reduction, through standards and product-centred legislation and labelling, to corporate reporting and supply chain pressure. The process of market transformation is illustrated in Figure 2.6.

Figure 2.6 Market Transformation.



Source: Hinnells (1995).

The figure illustrates how markets can be transformed through government intervention, in this example the energy efficiency of cold appliances. The horizontal axis shows the relative energy efficiency graded from G, the least efficient, through to A, the best performing designs. The vertical axis shows the market share for each grade. Before intervention to promote energy efficiency, the market is dominated by poorly performing models. The introduction of minimum efficiency standards has the effect of removing the worst, G rated, models. Following appropriate labelling to guide consumers towards buying more efficient appliances, there is a further shift in favour of better efficiency. Most policies are aimed at the supply side of the equation. Transformation can be delivered through other policy measures. This can include fiscal incentives for consumers, such as rebates, or procurement policies, where the Government actively encourages favoured technologies. For example, two Government Departments, DETR and Customs and Excise respectively, gave a symbolic boost to 'green' electricity, aiming to buy 10% and 5% respectively from renewable sources within the next 3 years (ENDS 298, 1999). It is debatable how effective the proposed combination of policies will be, and one report suggested that labelling and subsidy schemes will be unable to achieve a significant increase for demand in for example, energy efficient appliances (ENDS 304, 2000).

The report reviewed the effectiveness of intervention, and concluded that labelling was only marginally effective mainly due to lack of in-store training in energy efficiency issues. The scheme to promote sales of energy efficient refrigerators was also criticised as the only models currently available is in the bands A to C, and all attract the same level of subsidy.

The UK government would clearly like to see greater development of markets for environmentally sensitive products and services, with a particular emphasis on eco-efficient solutions. To date, very little effort, such as market incentive schemes has been introduced. One exception is the Energy Savings Trust (EST), which claims the modest financial subsidy has boosted the installation of energy efficient boilers, and helped increase market share (ENDS 284, 1998). Other campaigns such as the reduction of VAT on environmentally-friendly goods and other fiscal help has been largely ignored. These are important issues that are likely to affect the markets for businesses studied in this investigation.

2.8.6. Summary of Support for SMEs

This section concludes with a brief review of European and UK policies that combine both environment and small business interests. Support is offered through a combination funding and information delivered through various agencies.

2.8.6.a. European Policies.

Turning first to European policies, the European Commission has expressed concern that all enterprises, including SMEs, are failing to incorporate sustainable development ideas into every day decisions. Hunter et al. (1997) summarised the objectives and measures and instruments introduced by the EU to influence industry. In summary, it is apparent that the great majority of measures are designed to stimulate greater resource efficiency and control the waste stream. Very little attention has been paid to the development and diffusion of 'ecologically friendly' goods.

More specifically, small businesses have assumed an important role in European policy development for other reasons, most significantly their potential capacity for resolving another critical issue, that of unemployment. For this reason considerable resources are being directed in devising policies aimed at promoting the interests of small firms because of the growing realisation that the well-being of the EU is dependent on the vitality of the small business sector, not least because of their economic and employment contribution. This has therefore been one of the main political motivations for targeting SMEs. For example, DGXXIII (1997) identified small craft based firms as potential solutions for growth and employment and could be a key factor for ensuring economic stability and social cohesion in the European Union. The DG also noted that SMEs could increase competitiveness and innovation through environmental diagnostic, consultation and information systems. In exploring SME initiatives, it is important to note that there exists a wide range of schemes that provide general support to smaller firms, some of which have an environmental emphasis. Many schemes have been instigated with the aim of improving conditions for SMEs, or disguise with an environmental blanket their real intent to create jobs.

More general financial support has been channelled through a number of programmes. These include the European Investment Fund (EIF), designed to assist smaller firms incorporate 'clean' technology or contribute to the development of goods or services enabling other firms to achieve a higher level of protection, and measures to protect and improve the environment (DGXXIII, 1998). The EIF provides co-finance for LIFE projects, which are projects linked to the environment. The EIF also encourages SMEs to register for an Environmental Audit, and is intended to assist small firms adopt the voluntary agreements on environmental management and the eco-audit scheme (EMAS), while the SAVE programme is designed to encourage energy efficiency.

The EU also suggested that greater access to information is key to encouraging small firms to become more environmentally aware (Andersson, 1997). The Council has expressed the need to integrate environmental requirements into business to business relationships.

This could include a code of conduct with environmental criteria on the provision of financial services to SMEs, strengthening product labelling, Environmental Management Systems, and promoting 'green' purchasing policies by public authorities (ENDS 273, 1997). Such voluntary schemes operate in the context of the increasing amount and range of environmental legislation.

2.8.6.b. SME Environmental Support in the UK.

The second part deals with the main UK agencies that effect small business support. The main channel for delivering assistance SMEs is through the Business Link organisations, originally funded by the Department of Trade and Industry (DTI). These operate as a regional 'one stop shop', intended to meet the general information needs of the SME community. They also complement the role of a growing number of 'Green Business Clubs'. The principle message to businesses at present is to encourage compliance with appropriate regulations, reduce waste and increase process efficiency. This can imply improving energy usage through a management system of 'good house keeping' or investing in more efficient equipment. It also tends to address waste minimisation issues, particularly packaging costs, since businesses are liable for waste disposal costs following the introduction of the landfill tax, and introduce the spirit of 'the polluter pays' (ENDS 282, 1998a; Hutchinson and Hutchinson, 1997). Waste can also refer to discarded or unused raw materials, representing an economic inefficiency. These techniques are intended to save businesses money by controlling their operating costs. Such savings could then be diverted into developing new processes and products.

2.8.6.c. A Review of Environmental Support Schemes for UK SMEs.

This section summarises the effectiveness of agencies intended to respond to SME needs and takes into account research that identifies preferred organisations. It concludes with a brief review of the fate of some of the schemes identified and the future of business support agencies.

Environmental initiatives targeted at UK SMEs tend to be delivered in the form of highly sector specific or more general information, rather than as direct financial assistance.

The main government agencies responsible for the delivery of such policies are the DTI and DETR. The DTI has tended to favour the establishment of regional 'one stop shops' to provide SMEs with general advice including starting a small business, exporting, employment and Information Technology (DTI, 2000). Environmentally driven projects are devolved to the Energy Technology Support Unit (ETSU) at Harwell, who operate the various schemes under the ETBP programme, including energy efficiency, SCEEMAS and waste minimisation projects.

In reality, SMEs prefer to contact a wide range of organisations for their business or environmental information. The Groundwork Trust (1998) showed that for general business matters they tend to contact their Local Authorities, Chambers of Commerce or Trade Associations for specific advice. They rarely make use of the various sources of advice about the environment. When they do need information, they prefer it to be delivered directly and on-site or through a telephone help-line, supported with documentation. It was suggested that external bodies, including the Environment Agency, customers and insurers all have the potential to persuade SMEs to change their environmental practices. The survey was more positive about attitudes, and indicated that now many SMEs accept that better environmental practice will save costs and improve their relationships with customers. This view contrasts with Holt et al. (1998), who found SMEs to be largely unresponsive, and may be reluctant to approach an external body where legislative compliance may be investigated. In addition, there has been an explosion in the number of often overlapping agencies to the extent that SME managers are unable to decide which to trust. This situation is compounded by the problem that the information provided may be so generic to be useless, or too detailed to be rapidly assimilated into working practices.

The business response to Government sponsored schemes has been variable. The waste minimisation clubs appear to have been the most successful, both in cost savings to individual businesses and reductions in emissions to the environment. This is probably because appropriate action is easily effected and incurs little managerial input or financial investment.

The success of the waste minimisation exercises contrasts with both the small business environmental management support scheme (SCEEMAS) and the more generic product eco-labelling scheme. Interest in management systems is increasing, but industry appears to favour ISO 14001 to EMAS (ENDS 279, 1998c). Applications from small firms to the SCEEMAS were disappointing, in spite of the subsidy available. Although launched in 1995, by 1996 only 54 firms had applied (ENDS 260, 1996), and the scheme was finally abandoned in 1998 (ENDS 282, 1998b). EMS in SMEs has also faltered, not least because firms lack resources and experience instability in management structures. These problems are compounded by the marginalisation of environmental issues from core activities combined with pressure of other initiatives diverting limited staff (Hillary, 1997). Palmer (1997a and 1997b) found that where EMS were introduced, it was done so on an ad hoc basis, and observed;

"Commercial incentives may be necessary to persuade a smaller organisation to take some action, they are only rarely sufficient to make the environment a concern for top managers."

This research concluded that the economic return alone does not justify the investment of their time in better environmental management, and it appears such systems are better suited to large organisations.

Environmental product labelling schemes are facing similar difficulties in persuading small firms of their advantages. The EC Eco-label scheme, like management systems, is more appropriate for large enterprises, and is dominated by products originating from large companies, the majority of which are UK based (ENDS 274, 1997).

However, while independent national schemes have become well established, notably the Nordic White Swan and the German Blue Angel, the EC scheme has attracted little attention from business. Mandatory energy labels on a range of white goods, including refrigerators and freezers have been introduced throughout Europe, but the process has been slow. The EU commenced discussions about labelling in 1979, but the first labels only appeared in 1995, and in the UK labelling is supported with information campaigns and rebates for domestic energy consumers (Boardman et al. 1997).

The evidence that labelling is persuading consumers to change their purchasing behaviour is not borne out by the abolition of the UK eco-labelling board (ENDS 291, 1999b), a tacit recognition of the failure of the scheme, whose shortcomings have been described by Smith and Potter (1996). Further, product labelling is restricted to final goods for the eco-label, and specific components, such as plastics to facilitate recycling. The product categories, such as washing machines covered by the EU scheme effectively exclude SMEs.

Finally, Curran and Blackburn (1990) predicted that government small firm support would decline during the last decade, with considerable uncertainty surrounding the fate of the Business Link service (DTI, 1998). Bryson (1997) was highly critical of the service provided by Business Links; and identified several major flaws in their operation. Firstly, they create a local monopoly of expertise, with little incentive to transfer knowledge to other regions. Second, the government's evaluation process determines their activities. Finally, he argues that they aim to identify firms that are likely to grow, which reflects a need for efficient administration, or cost effectiveness, rather than stimulating development of the local economy. The evidence from the DTI (2000) about the latest reorganisation of the service, and the creation of a dedicated Small Business Service does little to refute any of these criticisms.

2.8.6.d. Concluding Remarks.

The evidence suggests that many manufacturing based SMEs are facing increasing pressure to improve their environmental performance, through a combination of regulation, standards and their supply chain. It has been recognised that they have limited resources to cope with the additional burden this represents, so a range of Government backed programmes have been introduced. These have largely focused on cost reduction strategies, attained by the installation of 'clean technologies', and driven by the eco-efficiency debate. There is also a lack of information that enable small businesses integrate environmental management or strategies within their overall strategic development. Comparatively little effort has been directed to establishing what form of assistance SMEs require, if they are to improve their environmental performance through developing environmentally sensitive products or services, and integrating this information into other strategic decision making processes.

Little attention has been paid to stimulating market demand for environmentally-sound goods and services. The main thrust of policies and measures applied has been to transform non-green firms, rather than encourage the creation or development of 'green' enterprises. Some industrial sectors, including chemicals, steel and transportation equipment are dominated by large scale, resource intensive enterprises. The consequent industrial pollution can be attributed to a few very large facilities. However, given the wide geographical spread of SMEs, their contribution to the overall environmental loading is amplified. Many of the environmentally driven schemes initiated have been geared to addressing the processes common in large enterprises. Until recently, there has been little attention devoted to the problems peculiar to SMEs, which cannot be dismissed as simply scaled down versions of large enterprises. Numerous schemes have been introduced with the aim of improving conditions for all types of firms, from financial assistance through to industry specific, process centred information.

2.9 Innovation Theory; Environment as a Driver.

Removing the faults in a stagecoach may produce a perfect stagecoach, but it is unlikely to produce the first motor car.

Edward de Bono.

2.9.1. Introduction.

This section outlines three areas central to this study of innovation and small firms:

1. The principle theoretical aspects of innovation that frame this research,
2. An examination of the nature of innovation in SMEs
3. The role of environmental issues as a driver for new products and processes.

2.9.2. Theoretical perspectives.

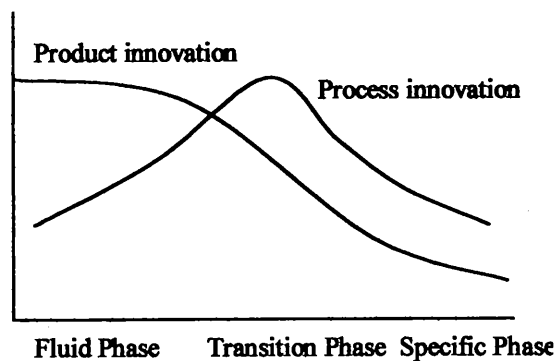
At this stage, it is useful to introduce a definition of innovation. Dosi (1988) defines it as a process that involves;

“The search for and discovery, experimentation, development, imitation and adoption of new products, new processes and new organizational set-ups.”

This definition is particularly helpful because it acknowledges that innovation is not limited to purely technological advances, but embraces social and managerial change. Schumpeter (1934) conceived of innovation as a highly idealised, linear process, where the market informs the selection environment for technologies. Here, a virtuous circle of investment in R&D successful innovation is rewarded by increased monetary profit and leads to increased competition. Rothwell (1992) built on Schumpeter's linear market pull-technology push model with his 5th generation model, that, integrated other, parallel functions and interactions. Subsequent linear, or directional views of innovation have tended to be replaced by non-linear models (Freeman, 1996; Woolgar, et al. 1998; Conway and Steward, 1996) that recognise the limitations of simple market pull-technology push approaches. It is more realistic for innovation to be framed by the wider selection environment, including regulations, actual and potential markets and customers. Innovation may be prompted by external organisations, such as customers and suppliers (Hippel, 1988), or internal company interactions, such as marketing and R&D departments (Rothwell et al. 1974). The process of innovation can also be seen as analogous to biological evolution (Nelson and Winter, 1977; Green and Miles, 1996). In this perspective, innovation is a combination of both continuous, or incremental modifications to existing systems, coupled with periodic bursts of discontinuous, or radical changes (Gouldson and Murphy, 1998). Utterback (1994) extends this comparison further, but takes a very narrow, technical perspective, illustrated with reference to, among others, the lighting industry. In this model, innovation follows a 'S' shaped pattern of creation, development and diffusion, a theme shared by an ecological view of natural systems (Krebs, 1985).

This represents the pattern of growth in natural populations, with an initial ‘lag’ phase of low growth followed by rapid, even exponential growth and a final plateau. The innovation process in an enterprise commences with a ‘fluid phase’, where developing new products demands new processes. In the following ‘transitional phase’, the processes are refined or streamlined, new products mature and the technology diffuses. Finally, firms enter a ‘specific phase’, characterised by comparatively little innovation in either product or process. Both may have reached technological limits, and the regime may be displaced by a successive wave of technology. The model is illustrated in Figure 2.7.

Figure 2.7. Product and Process Innovation Phases.



Source: Utterback (1994).

This simplistic view of innovation makes the assumption that the innovator is also an astute entrepreneur, and capable of successfully marketing the resulting products. Following this theme of technological discontinuity, Gardiner and Rothwell (1989) contended that big, regime changing technologies are followed by arguably more important smaller innovations, which may lead to tactical changes to increase both productivity and competitiveness. In this scenario, redesign strategies are both dynamic and challenging. Further, the ‘followers’ rather than the ‘leaders’ in a particular technology may not always be the most successful at exploiting its potential (Nelson and Winter, 1977). It is not just the scale of technological innovation that is important, but also the rate. As the OECD (1991) observed, given current trends;

“If present trends continue, 50% of the products that will be used in 15 years’ time do not yet exist.”

OECD (1991).

Two observations can be made about innovation that shapes this research project. The first is that few studies distinguish between innovation in products and services, although Coombs and Tomlinson (1998) found that common innovation processes occur, and product based firms are increasingly incorporating service elements. The second aspect was that these enterprises recognised the necessity for collaboration with other firms, including their competitors, as they identified gaps in their knowledge base. Alliances and networks are pivotal for smaller firms seeking to establish greater stability and certainty (Storey and Karlsson, 1998).

2.9.3. Innovation and Small Firms.

One of the key elements of innovation is the risk or uncertainty incurred by a firm (Nelson and Winter, 1977). Paradoxically, small firms need to embrace innovation for survival, but are faced with the dilemma of choosing which technology to pursue, because they have limited resources to explore the market potential of all the alternatives available (Dodgson and Rothwell, 1989; Schmidheiny, 1992). Balancing the need to develop future innovations with investment in current production creates a tension between the need to continue with incremental improvements and innovative, new products that could determine the survival of a firm. As Utterback (1994) observed;

"Firms owe it to themselves to improve and extend the lives of profitable product lines. These represent important cash flows to the firm and links to existing customers. They provide the funds that will finance future products. At the same time, managers must not neglect pleas that advocate major commitments to new initiatives. Typically top management is pulled by two opposing, responsible forces: those that demand commitment to the old, and those that advocate for the future. Unfortunately, advocacy tends to overstate the market potential of new product lines and understate their costs."

Utterback (1994, p. 216).

Small firms are not necessarily more innovative than their larger counterparts, but may be well positioned to develop basic technologies and niche markets.

For example as Curran (1996) observed Bell Laboratories were instrumental in the highly expensive early stages of the development of transistors, but small firms applied the technology to new products. Smaller firms are well positioned to create niche markets that are not worth the initial investment by larger firms as returns may be too trivial or the market unstable. Eventually some applications do mature and generate sufficient interest from bigger organisations that either move into the market with their own products, or buy out the original innovators. In their extremely thorough review of innovation in SMEs, Hoffman et al (1998) concluded that although there has been considerable research into SMEs, surprisingly little is known about the volume of SMEs that innovate, and the exact quantity, nature and commercial value of their innovations. In addition, the authors noted that there is insufficient research to guide government SME policy. This is because most studies fail to differentiate between product and service-based firms, or concentrates on micro-scale and start-up enterprises. The authors revealed some important features common to the SME innovative effort:

- They are more likely to involve product rather than process innovation,
- They are focused on products for niche rather than mass markets,
- They are more frequently organised in larger firms, but ad hoc or project driven in smaller firms
- Innovation is more common in final product firms, and least likely in component sub-contractors,
- SMEs will generate incremental and major breakthroughs in all sectors,
- Are likely to be associated with growth in output, turnover and employment. This implies that static or low growth firms are either unsuccessful innovators, or fail to compete in other aspects,
- Will frequently involve some external linkages.

Adapted from Hoffman et al. (1998).

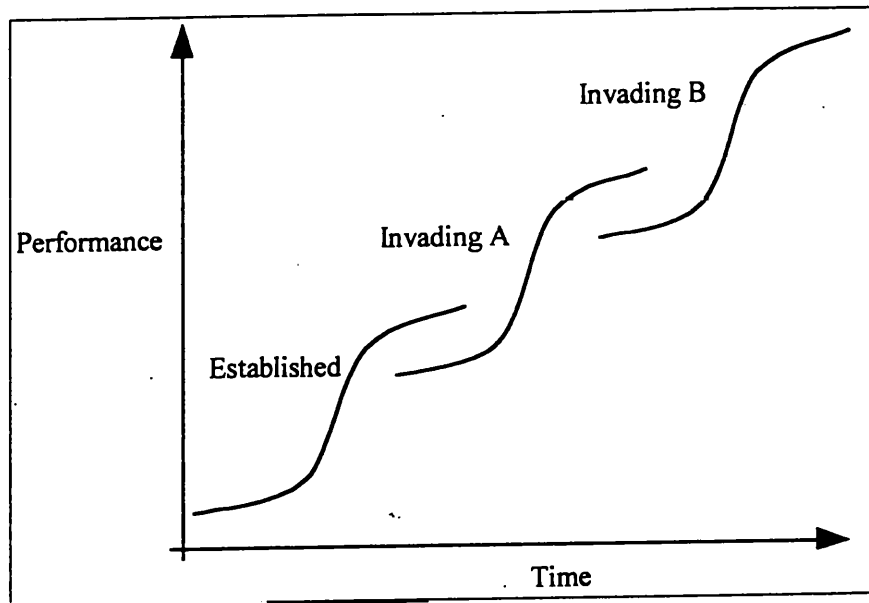
This raises some serious issues for policy makers. It is extremely difficult to spot growth oriented firms, and it may be most profitable to provide support for proven firms with unrealised growth rather than attempt to locate surviving start-up firms.

The authors also doubt the optimism expressed by Dodgson and Rothwell (1989) for the contribution made by high technology based firms. Woolgar et al. (1998) and Conway and Steward (1996) found that external, informal networks, and particularly links with Universities were important factors in the successful transfer of new technologies from participating Colleges. This networking may extend to include their rivals (Storey, 1998). Counterbalancing this optimistic review, there is little doubt that small firms face a number of barriers to innovation, in contrast to large firms. These are most notably access to capital, information, and skills for assessing technological alternatives and negotiating contractual arrangements (Schmidheiny, 1992). Some of the issues that involve aspects of innovation, principally the differentiation between manufacturing and service delivery, strategies for expansion and the nature of external networks will be developed further in the design of this study. It is appropriate to discuss how environmental issues have evolved as a strategy for innovation.

2.9.4. Environmental Innovation and SMEs.

For the first time, environmental issues are becoming important as a driver of technological innovation that influences both product and process design. Christie (1995), although sceptical of the degree that environmental issues have become important for many businesses, outlines the shift from 'end-of-pipe' solutions to 'cleaner technology', often forced by legislation imposed through public concern (Groenewegen and Vergragt, 1991). Cairncross (1991) predicted that the next generation of products will be those that minimise the use of resources. Green et al (1994) and Smith et al (1996) found that innovation was often associated with current and anticipated environmental regulations, or the prospect of new, 'green' markets. Utterback's 'wave' model of innovation (Utterback, 1994) can be adapted to reflect environmental issues for the first time as a source of another wave of innovation. This process is illustrated in Figure 2.8.

Figure 2.8. Waves of Increasing Product Performance.



Adapted from Utterback (1994).

This diagram shows how succeeding waves of innovation display three phases forming an 'S' shaped curve. First there is an initial lag phase, as a technology develops, and process and product innovation is critical for success. Once established, the pace of technology increases before finally slowing as products mature. Utterback (1994) makes two key observations. Initially, the technical performance of the invader may not match that of the established technology, but eventually the greater potential is realised. The businesses built around the established technology may display a burst of innovation in order to compete, but usually fail. In subsequent waves, 'established' firms are superseded by an 'invading' technology, and organisations that are superseded rarely make the transition to adopting new ideas. In the illustration, the third wave represents innovation of products that recognise the environmental imperative. Green et al. (1994) argued that through competitive pressure technological regimes could shift to a more sustainable basis. Some mature technologies already display greater environmental awareness because of the necessity to reduce operating costs by optimising production techniques. Alternatively, Groenewegen and Vergragt (1991) suggested that diffusion of such ideas occur through networks of technology, products, innovation and strategic positioning by companies, spurred by a mixture of threats and opportunities.

Their study concluded with some indicators of environmental friendliness of products and processes, which reflect a combination of eco-modernity and industrial ecology approaches. Industrial innovation strategies now reflect environmental concerns for the first time, and this may be the dominating force behind the next generation of technologies. It is timely to examine the theoretical and practical implications of such innovation.

2.10 Eco-Design; from Environmental Technology to Sustainable Design

2.10.1. Eco-Design Innovation; Theory & Strategies.

This final section explores in further detail the theoretical and practical aspects of eco-design, with particular attention on eco-efficiency and dematerialisation strategies, the main underlying principles applied to this area of product design and research. The section is structured as follows:

- An introduction to the terminology used, from environmental technology to sustainable design.
- A review of 'green' design.
- Metrics for assessing the environmental profile of products.
- Eco-Design in context.
- Conclusions and emerging research questions.

A new terminology is developing to describe developments in the field of environmentally focused product innovation. The definitions used are often interchangeable, from environmental technology through to sustainable technology.

A useful hierarchy was outlined by Dewberry and Goggin (1996), shown in Chapter 1 and summarised below:

- **Environmental design**; 'end-of-pipe' solutions to prevent pollution utilising 'environmental technology'.
- **Green design**; single issue focus. For example, recycling, waste minimisation or energy efficiency.
- **Ecodesign**; based on a thorough life cycle approach, attempting to balance the environmental impacts from 'cradle to grave'.
- **Sustainable design**; emphasises long term, radical system innovations, ethical approach, dematerialisation and the move towards service provision as opposed to products, incorporates eco-design principles.

The hierarchy reflects the shift from purely controlling industrial processes by the application of environmental technology solutions to more fundamental questions raised about products and product systems. The more far-sighted strategies blend organisational issues with technological advances (Verheul and Vergragt, 1995; Vickers and Cordey-Hayes, 1999) to create what Shrivastava (1995) termed 'sustainable organizational design'.

2.10.2. Environmental Technology.

Environmental technology includes 'end of pipe' solutions, which are measures to control pollution after it has been produced (OECD, 1996). Environmental technology focuses on equipment designed to control, monitor and remove pollutants, divert materials from waste streams, 'clean' production, improve the energy efficiency of production and permit the saving of energy. Businesses in this industry are dependant on the threat and enforcement of increasingly stringent environmental legislation. The sector is extremely diverse, covering waste and water services, environmental equipment and consultancies. The economic importance, and in particular the export potential for the UK economy should not be overlooked.

The global market is currently valued at an estimated £154 billion, and likely to reach £428 billion by 2010. The UK accounts for some 4% of this market, with sales of £8 billion (ENDS 278, 1998). An important dimension of environmental technology is the nature of the commercial risk involved. The 'cost effectiveness' of investment in pollution control technology underlies 'Best Available Technology Not Entailing Excessive Cost' (BATNEEC) projects (ETBPP, 1998). In practice, BATNEEC can only be applied when the technical solutions already exist, and can be valued, or there are clear methods to optimise inefficient techniques. It is usually applied to justify expenditure on appropriate modifications to existing processes, rather than direct effort in new product innovations.

2.10.3. 'Green' Design.

Environmental technology focuses on short term, expedient solutions. A first step that tends to address product redesign and departs from this philosophy is 'green' design, defined by the US Office of Technology Assessment (OTA) as;

"A design process in which environmental attributes are treated as design objectives, rather than as constraints.....green design incorporates environmental objectives with minimum loss to product performance, useful life or functionality."

OTA (1992).

'Green' design typically addresses one or two high profile environmental aspects of a product, such as energy consumption or material recycling, and tends to address the redesign of existing products. There is an implicit assumption that society has a demand for such products and that design fulfils that demand. It will be seen how this has been achieved in a small firm context in the following chapter. Such a strategy can be commercially successful (Smith et al. 1996; Dermody, 1994). Inevitably, there are various interpretations of the meaning of 'green' when applied to products. This problem was exacerbated by the rash of so-called environmentally friendly consumer goods in the late 1980s, many of which failed to deliver environmental benefits or were of poor quality and often promoted with unsubstantiated or spurious claims (Potter with Dewberry, 1993).

One approach to resolving the issue has been the introduction of product labelling, including the previously described EU Ecolabel scheme (Smith, 1993). This sought to clarify and verify environmental claims of products using Life Cycle Analysis (LCA). Some businesses, including small firms, have recognised the potential competitive advantages to be gained from producing 'green' products due to growing consumer interest in the market niche of environmentally friendly commodities (Bhate and Lawler, 1997; Smith et al. 1996), and are of particular interest in this study.

2.10.4. Product Profiling Techniques; Life Cycle Analysis.

LCA originated from energy audits of the late 1960s, and is a useful tool for quantifying and locating the environmental impacts of a process or product. The technique comprises an inventory of the energy and raw materials used in the production, and how much solid, liquid and gaseous waste is generated at each stage of a product's life. The development of LCA offers a tool for the comparison of the quantitative environmental impacts of different commodities. This technique enables the determination of the impacts of a product from 'cradle to grave', or from raw material extraction, production, distribution, use and eventual disposal. The Society of Environmental Toxicologists and Chemists (SETAC) summarise LCA as;

'A process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and material uses and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling and final disposal.'

SETAC (1991).

The assessment process of LCA comprises four phases;

1. *Inventory*, where the relevant data are collected
2. *Classification*, where these data are translated into environmental effects
3. *Evaluation*, where an attempt is made to compare and contrast the various impacts and reach a conclusion about the relative or absolute pollution attributable to a product or process.
4. *Improvement*, is implicit in the cyclical nature of the tool, where there has been some attempt to identify or quantify which aspects can be optimised from an environmental perspective.

Horst and Zweers (1994).

There are numerous approaches to conducting an LCA. One model that has been appropriated for use in the EU Ecolabel scheme is a matrix of form and location of impacts, coupled with suggested options for reducing those impacts. This is summarised in Figure 2.9.

Figure 2.9. Life Cycle Matrix.

<i>Environmental Impact</i>	<i>Pre-production & Production</i>	<i>Use</i>	<i>Disposal</i>
Energy	Efficient production processes; reduction of distribution	Reducing energy consumption; alternative power supplies	Non-energy intensive disassembly; appropriate disposal
Material	Minimising raw material; eliminating harmful materials	Design for quality; reducing need for new material for repairs	Design for disassembly; Cascading material cycles
Pollution (Emissions to air, water and soil)	Reducing production waste; eliminating toxic compounds	Eliminating hazardous emissions; reducing the 'short termism' approach to products	Appropriate disposal; Reuse or recycling preferred to landfill or incineration

Adapted from Dewberry (1996).

This framework has been adopted for establishing EU wide eco-labelling criteria for a range of product groups, including lighting, washing machines and textiles. The scheme shares many of the ideas promoted through similar consumer oriented policies, such as energy efficiency labels, but aims to reflect wider environmental concerns (Smith and Potter, 1996). Ecolabelling emerged primarily as an agent for consumer protection, as manufacturers attempted to exploit the growth of green consumerism with sometimes false and misleading claims regarding the true environmental impacts of some products. It was envisaged such a scheme would promote design, production, marketing and use of products with reduced environmental impacts during their entire life cycle (DTI/DoE, 1992).

Although it can be a powerful tool, there are conceptual and practical difficulties associated with their use and interpretation. Since a LCA is a 'cradle to grave' analysis, definitions of the boundaries have yet to be standardised. Access to relevant, usable and accurate information is also difficult, given the commercial nature of the information. It is also difficult to compare different impacts objectively, particularly waste emissions (Smith, 1993). The use of LCA is controversial and some issues are unresolved. For example, the EU Ecolabelling scheme is based on a matrix style LCA, and requires highly quantified, professionally presented data. In practice comprehensive and exhaustive LCAs are costly and time consuming. There is some consensus about the compilation of inventories once boundaries have been agreed, but considerable debate surrounds the comparison of the impacts of different emissions. For example, comparing the trade-off of gains made in reducing emissions of carbon dioxide at the expense of increasing the amount of toxic waste produced, or the potential loss of biodiversity, are highly debatable issues. Further uncertainty is introduced when using industry standard or process specific data, and any conclusions may be prejudiced by the sponsoring organisation. Finally, the outcome of a LCA can be very sensitive to initial assumptions, and most have been employed to defend products, rather than stimulate the development of environmentally benign products or processes (ENDS 264, 1997).

Welford and Jones (1994) recognised the value of Life Cycle Analysis as a function of product stewardship, which they regarded as one element of a sustainable business culture.

Although LCA is still in the experimental stage, and there are diverse practises, it has already been employed as an analytical tool in voluntary agreements, including the EU Ecolabelling scheme and the ISO14000 series of standards. This shows the convergence of use from a consumer protection measure to integration within management standards. The financial implications of conducting such a LCA presents a significant barrier to SMEs, who are unlikely to compete in markets with high entry costs, and where the benefits of a label are unproven (Smith and Potter, 1996). The cost, complexity, expertise required and increasing professionalisation of LCA renders the use of a full scale LCA inappropriate for many SMEs. There are increasing resources directed at more fundamental design issues, driven by a combination of ever tightening environmental legislation and the recognition of the considerable financial benefits arising from cost reduction, derived from greater resource efficiency. Many are more relevant to the needs of SMEs.

2.10.5. Alternative Approaches.

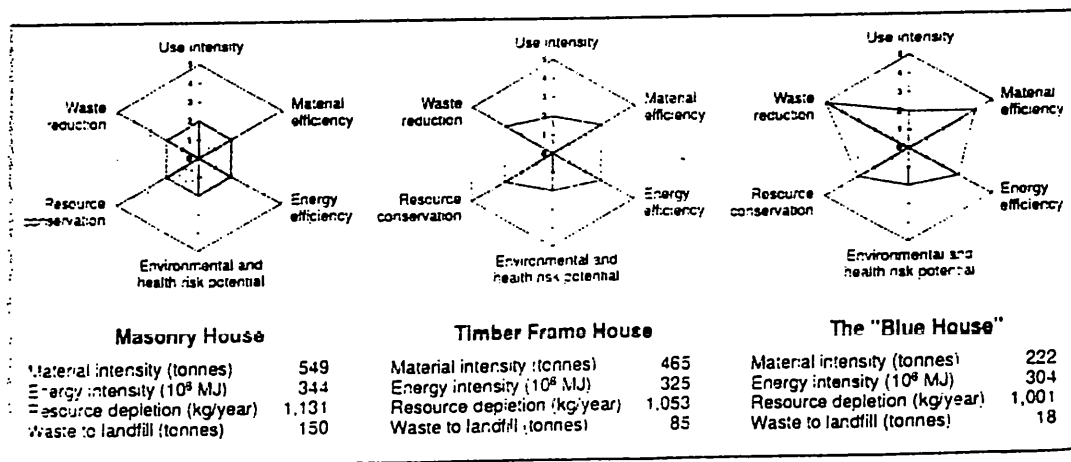
It is partly because of the problems with information intensive, costly and laborious LCA that other, more qualitative approaches could be more beneficial to SMEs. These include product stewardship 'checklists' or guidelines (Bor and Blom, 1994; Schmidheiny, 1992), energy or material flow diagrams (Thurston, 1994). Horst and Zweers (1994) reviewed several alternative approaches to assessing products:

- Economic life cycles (see also Evans and McAloone (1996))
- Closing materials cycles
- Energy indicators
- Hazardous waste inventories
- Environmental marketing and environmental legislation.

The following list includes some examples that illustrate 'footprint', 'ecowheel' or multi-dimensional graphical representations of various environmental aspects of a product or business. (See for example Hemel, 1996 and 1998; Dewberry, 1996).

- The Ecological Footprint was devised by Wackernagel and Rees (1996) and enables the calculation of resource use in terms of land take for food, wood and energy production, and aggregates CO₂ emissions to a single indicator.
- The 'Factor Four' (Weizsäcker et al. 1995) visualised the mass or volume of 'rucksacks' associated with the production of a kilogram of product. For example, a gold ring weighing just ten grams has an associated 'rucksack' of some 3 tonnes which allows for the energy consumed in extraction, refining and production of the metal, tailings from mining the ore, water consumption and transport costs, among the many impacts.
- Volvo cars (ENDS 288, 1999) developed a four axis model covering manufacturing, operation, recycling and management to profile some 12 environmental indicators from exhaust emissions, material labelling for recycling through to energy used in manufacture. This is novel because it includes the service element of motoring through monitoring certification.
- Dow Europe, the chemical firm, has developed a 'spiderweb' diagram that represents six dimensions of eco-efficiency, and is shown below.

Figure 2.10. Dow Spiderweb Diagrams and Eco-Profiles of Different Methods of Building Construction.



Source: ENDS 252 (1996).

The external boundary of the hexagon represents the 'ideal' profile. The inner shapes indicate how far each of these three designs is removed from the ideal on six parameters. This is a particularly useful approach, as it permits the clustering of disparate information. In this example of three construction techniques, it allows the direct comparison of material and energy intensity, resource depletion and waste. The analysis provides an immediate visual representation of product performance over six parameters, from use intensity, material and energy efficiency, environmental risk, through to resource conservation and waste reduction. The 'Blue House' design capitalises on the mechanical and insulation properties of polystyrene, illustrated by the waste reduction and material efficiency potential.

Other approaches are more practically oriented. Hemel and Brezet's (1997) manual builds on practical industrial experience and considers the implications of consumption patterns. Hemel's novel approach to the pictorial representation of LCA is exploited in this study, as unlike the preceding examples it was designed specifically to introduce small firms to the principles of eco-design.

There are now many commercially available packages to assist firms to conduct their own LCA. A range of these tools were reviewed by Caluwe (1997) who concluded many have limited application, demand considerable user input, and offer little scope for diversive design thinking. This problem can be illustrated by the number of tools available to designers in the electronics industry to facilitate the recycling and reuse of used equipment such as mobile phones. Many manuals have emerged to enable product design from a 'design for disassembly', recycling or product re-design perspective (ENDS 283, 1998; McLaren et al. 1997; Henstock, 1988). Others have developed more generic guidelines (Simon et al. 1998; Meinders, 1997; Goedkoop, 1994). These have limited or little use for most SMEs.

2.10.6. Eco-Design and Beyond.

In contrast to 'green' product design, eco-design demands process, product and system level evaluation to achieve long term solutions, while sustainable design embodies a radical, holistic approach to products and services.

The kinds of systems embodied by this approach have been described as 'Environmentally Sound Technologies', defined as products or services that;

"Protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products and handle residual wastes in a more acceptable manner than technologies for which they are substitutes."

Regency Corporation (1998).

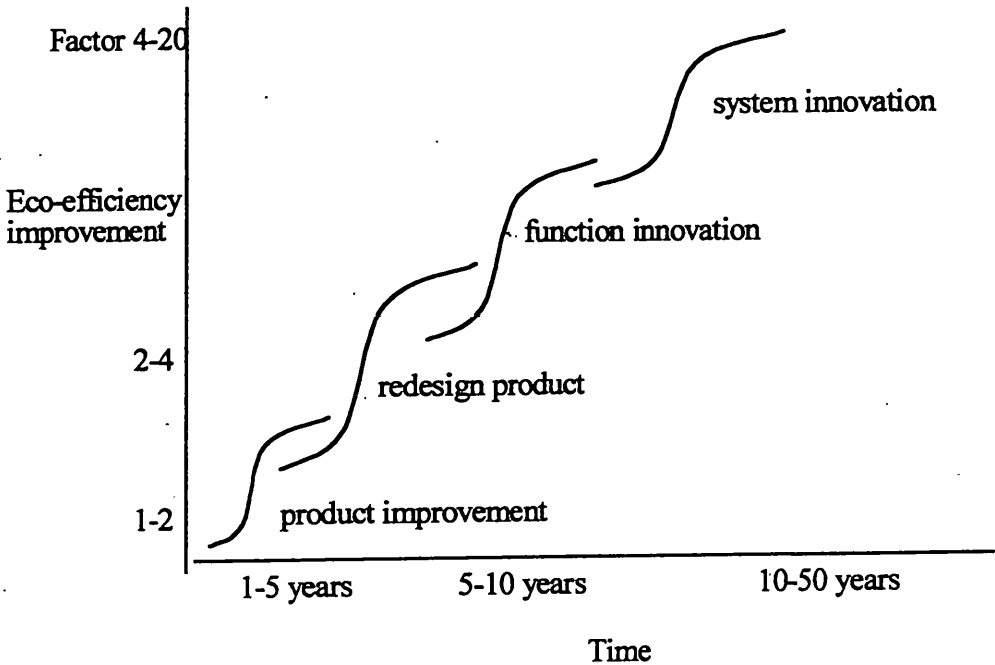
This broad definition includes environmental technology, but it provides a useful starting point for considering the industries suitable for this study. More conceptual perspectives of eco-design include the dematerialisation of economies through the transformation of products to services as proposed by Hukkinen (1995), Manzini (1990) and Dewberry and Goggin (1996) and Rocci (1997). Dematerialisation in this context is defined by Bernadini and Galli (1993) as;

"The reduction in raw material (energy and material) intensity of economic activities, measured as the ratio of energy consumption in physical terms to the gross domestic product (GDP) in deflated constant terms."

Eco design and sustainable design sprang from concerns that current technological trajectories are unsustainable, and may reach limits of refinement (Ernst & Young and SPRU, 1998). The idea extends beyond the traditionally accepted boundaries of what constitutes a business, and effectively demands a transition to a sustainable society based on such business practices (Shrivastava and Hart, 1995; Fussler and James, 1996; Isaak, 1998). The main forces driving eco-design are the previously outlined strategies of eco-efficiency and dematerialisation. The strategic implications of eco-design have been framed in a range of theoretical models, and include life cycle analysis, system level innovation, leap-frog strategies and eco-innovation (Hoed, 1997). The eco-innovation model developed by Brezet (1997) embraces four levels of environmental innovation. This ranges from product improvement, product redesign, function innovation to system level innovation. These are almost synonymous with the 'green', 'eco' and 'sustainable' design approaches already described.

This model focuses on the eco-efficiency argument, where it is hypothesised that a factor 20 performance improvement could be achieved with material and energy efficiency during the next 50 years. It is suggested that the greatest challenges will be in overcoming the current cultural and systems level constraints. The model is shown in Figure 2.11.

Figure. 2.11. Four levels of Environmental Innovation.



Adapted from Brezet (1997).

There is a similarity between this vision of innovation and Utterback's (1994) interpretation of succeeding 'S' curves of technology. The key difference is that each wave builds on previous environmental gains, rather than narrow technological advantages. The first type of design improvement involves product redesign from a pollution prevention position, synonymous with environmental technology. With the second type of improvement, the product concept also remains unchanged, but parts of the product are developed further. This perspective incorporates use of the LCA as a tool for identifying design options. The third type takes the current function as the starting point for investigating new ways to deliver those functions. The final type demands changes in related infrastructure and organisations to develop new products and services at a systemic level. The various stages are summarised in Table 2.5.

Table 2.5. Summary of Levels of Environmental Innovation.

<i>Product Improvement</i>	Synonymous with process improvement; greening 'non-green' firms. Process improvement may result in product innovation; conversely, product innovation demands process innovation.
<i>Redesign Product</i>	Characteristics of 'green' firms. They utilise materials selected on the basis of environmental impact, or deliver the service element with an improved environmental performance. They demonstrate awareness of their own environmental performance and are well positioned to make further innovations.
<i>Function Innovation</i>	
<i>System Innovation</i>	Green firms are limited by the current economic system. They require major government level intervention and different market dynamics coupled with cultural shifts and changes in behavioural patterns.

This model is useful for categorising SMEs. Most are at the first level, but some have progressed to the second, and a few to the third stage. It may suggest a route to a holistic approach to product innovation. Few industries have progressed beyond what Roy (1994) termed the first, 'exploratory' stages of the product evolutionary cycle. In practice, larger companies, for example, Dow, Philips, IBM and BT have appreciated the wider strategic implications of eco-design for their long-term survival and prosperity. There is great potential for SMEs to contribute to sustainability. UNEP (UNEP, 1997) outline seven elements of a sustainable product, while Weenen (1999) contributes some attributes of sustainable small businesses. Both are summarised in Table 2.6.

This kind of strategic approach to product design is also fundamental to the programmes introduced in the Netherlands that introduced SMEs to environmental issues through their products and the advantages of eco-redesign. This programme introduced small businesses in the Netherlands to eco-design principles, and helped translate theory into practice to enable firms to benefit from increasing market opportunities for environmentally friendly products.

Table 2.6 Sustainable Products and SMEs.

<i>Sustainable Products</i>	<i>Sustainable Enterprises</i>
Services as products	They focus on elementary needs, and present original, new or more sustainable solutions than those that prevail in the market
Strategic or holistic design	They utilise sustainable resources
Optimised design	They integrate social, economic, health and environmental issues
Dematerialisation	They adopt the locally based business implications of sustainability
Life Cycle design	They are part of local or regional initiatives, and mark the beginning of regional sustainable industrial development.
Longevity	
Positive aspects outweigh negative aspects.	
Adapted from UNEP (1997)	Adapted from Weenen (1999)

According to Hartman (1997), the project was designed to assist innovative SMEs, because small firms account for some 90% of product innovations launched each year, but lack the resources to focus on the environmental aspects of their own products, processes or environmental regulations. This thinking resulted in the 'Milion' project, which employed the 'ecowheel' concept outlined by Hemel (1996). The underlying eco-design principles that founded the programme are summarised as follows:

- Select low impact materials. Use clean, low embodied energy, recycled or reusable materials.
- Reduce material. Reduce weight and transport volume.
- Optimise production techniques. Use less energy, produce less waste.
- Optimise distribution system. Use less packaging and energy efficient logistics.
- Reduce impact during use. Reduce energy consumption, use clean energy sources, reduce consumables.
- Optimise initial lifetime. Increase durability and reliability, design for ease of maintenance, modular product architecture.

- Optimise end-of-life. Design for reuse, remanufacture, recycling or safe disposal.
- New functionality. Aim for dematerialisation, shared use of products, integration of functions.

Source: adapted from Hemel (1998).

The eco-design project, and the use of the eco-wheel, will be described in greater detail in the following chapter that details the methodology adopted for this research programme.

Eco-design is an attempt to synthesise environmental considerations into product and service innovation. This can be accomplished using a variety of tools and techniques depending on the context. The pressure to introduce eco-design within a business depends on its strategies. Some are motivated by consumer concerns and seek compliance with 'green' labelling schemes, others use it to reduce manufacturing costs. It has mainly been the preserve of large organisations that have also explored the implications of sustainable design. This approach attempts to incorporate social and ethical considerations into the execution of business practices. The capacity for extending the commercial and environmental benefits to the small business community has been generally overlooked.

2.10. 7. Concluding Remarks.

This chapter outlines the main theoretical aspects of this research, including general trends in industrial transformation, the role of (SMEs) in the economy and their environmental impact. It has also considered the wider industrial response to the environmental agenda, and how small firms can contribute to develop solutions arising from the demand for environmentally conscious goods and services.

Environmental issues are now on political and industrial agendas. They are post-modern phenomena, reflecting the age of scientific uncertainty. Businesses are not immune from the influence of environmental issues. From localised noise, water and air pollution to the potentially catastrophic effects of climate change, these problems have also been scrutinised by policy makers.

The legislative response has shifted from 'end-of-pipe' solutions that may experience technological limitations to product design issues that offer greater scope for solving environmental problems. This has also witnessed the growth of market based instruments, such as product labelling, which are now viewed as more persuasive than traditional 'command and control' edicts. Regulation has benefited industries that directly resolve environmental problems, referred to as 'environmental technology'. The market orientated tools, such as product labelling, favour indirect solutions, such as products with reduced environmental damage compared to the artefacts they are designed to replace.

Although the industrial response to environmental issues was initially hostile, it has been reluctantly acknowledged. Business was eventually convinced of the arguments presented as cost-cutting exercises through eco-efficiency measures, rather than rationalising the ecological merits from an industrial ecology perspective. Environmental issues have translated into the competitive strategy of some corporations that have recognised the commercial advantages offered by a proactive stance that may also reflect the ethical issues of an enterprise.

The rise of environmental issues is matched by the concurrent reshaping of industry and the reassertion of small firms in the economy. The post-Fordist transformation recognises that although larger firms wield considerable economic and political power, small enterprises are also increasing in importance for a variety of reasons. They provide a stabilising force, and are therefore important from both a social and economic perspective, and they are an important source of innovation.

Interest in the well-being of small enterprises has been largely linked to their function as a source of employment. This raises issues about the determinants of their creation, survival and growth. This is a notoriously complex arena, and it has proved extremely difficult to predict long term performance and viability. This presents problems for governments regarding the investment of public funds into directing business support strategies, and private investors for the same reasons.

There are a complex set of motivations underlying every business venture, and it is untrue to suggest that all intend to grow and develop, although some undoubtedly possess the necessary ingredients to achieve significant growth. Many remain at a small scale, despite assistance and remain immune to any form of intervention.

Few SMEs have incorporated environmental issues into their general business decisions. Ironically, most SMEs expect that environmental issues will become more important in the future, and are unlikely to diminish. The evidence suggests that SME managers are concerned about environmental issues, but in practice rarely comply with appropriate regulations. This is not necessarily a deliberate avoidance of responsibilities, but reflects the pressure on SMEs to react to many issues simultaneously. The environment is a low priority, and SMEs tend to be overwhelmed and confused by the volume of help now available. Some types of small enterprise do respond to environmental regulations and industrial standards, while voluntary schemes have a poor record. These reflect the current trend of eco-efficiency measures designed to optimise production processes and reduce waste by emphasising the cost reduction benefits. Market transformation policies, such as product labelling, intended to encourage the uptake of 'greener' technologies are more relevant to large enterprises.

It has been recognised that innovation is an important aspect of small firm success. Drawing on an evolutionary model of innovation, it can be hypothesised that environmental issues may be important drivers in the creation of a new generation of goods and services. Empirical evidence tends to focus on the activities of large firms that have the luxury of resources, both technical and organisational, to develop and exploit new products. They are able to internalise the process and use it as a strategic management tool by including environmental auditing and reporting. Commercial considerations can be realised through two discrete approaches to resolving environmental problems. The first is through the application of 'environmental technology', involving products or services that directly resolve the unwanted consequences of industrialisation. The second is through product design strategies that reduce the environmental burden of products. 'Green design' focuses attention on one or two high profile environmental aspects, identified through a LCA. More

challenging, 'eco-design' solutions require a holistic approach to design. There is little evidence to suggest firms have managed to introduce systematic product development strategies, or eco-design based on environmental criteria, often for good reasons. For many businesses, this would entail a radical departure from incremental changes to products and processes. Innovation theory coincides with environmentally inspired innovation to produce a perspective that visualises several stages of product and service evolution.

2.11. Emerging Research Questions.

The conclusions to this chapter suggest a number of areas that deserve greater attention as part of a research programme. This overview of the literature revealed that although there has been considerable research into many facets of small businesses, there remained some unanswered questions that this research will attempt to address. The following table summarises the issues and the questions that arise. It can be seen that the areas fall into five broad categories, outlined in Table 2.7.

This chapter has outlined the theoretical issues that underpin this study of small businesses. The methodological aspects of the empirical part of the project are detailed in the next chapter.

Table 2.7. Summary of Research and Areas for Investigation.

Area	Summary of Research	Areas for Investigation
Origins, survival and growth.	<ul style="list-style-type: none"> • There has been considerable attention devoted to the study of high technology, start-up firms for commercial and political reasons, despite the high failure rate of new enterprises. • SME research can oversimplify subtle differences between superficially similar firms. • SME research also tends to focus on 'micro-scale' enterprises, or mixes manufacturing with services. 	<ul style="list-style-type: none"> • For practical research reasons, comparatively little is known about business survival, growth and long term prospects, and how important initial conditions prove to be. • It is fallacious to assume that business motivation is purely about profit maximisation. Entrepreneurial behaviour is a far more complex subject. • It may be important to distinguish between 'non-micro' scale enterprises and between manufacturing and services.
The role of environmental regulations and standards in innovation	<ul style="list-style-type: none"> • The stereotype image of SMEs presumes that all firms are reactive, or non-compliant with environmental issues and legislation. Some SMEs appear to be under pressure to conform to Environmental management standards, often imposed through their supply chains. 	<ul style="list-style-type: none"> • The threat of environmental regulation or compliance with standards is often cited as a spur for action. How true this is in firms that have already pursued environmental objectives is unknown. • There is little known about small firms that have progressed beyond the superficial process or eco-efficiency optimisation route and are potentially responsive to external influences.
Eco-design innovation in context	<ul style="list-style-type: none"> • There is considerable anecdotal evidence that SMEs are great sources of innovation. In reality little is known about the extent or magnitude of their contribution, commercial value, or the impetus to innovate. Studies suggest small firms engage in niche markets and have an ad hoc approach to managing the process. • Small firms face a number of barriers to innovation, including access to capital, information, and skills for assessing technological options and negotiating favourable conditions with larger firms. 	<ul style="list-style-type: none"> • Few businesses, large or small, have incorporated 'green' aspects into their product or service designs. • The theoretical model of innovation that frames this study suggests 'waves' of technological creation. 'Green' innovation in SMEs may be part of such a 'wave'. This might mean technological and organisational innovation, and important to the survival of small firms. • Virtually nothing is known about the innovation capacity of firms that have launched 'green' products or services, what stimulated innovation and what conditions would favour their continued development.

(Table 2.7 Continued)

Area	Summary of Research	Areas for Investigation
Environmental profiling techniques of products and services	<ul style="list-style-type: none"> • Practical applications of Eco-design have been largely confined to large firms. Although there are a number of tools available, such as LCA packages, few SMEs have translated the theory into practice. 	<ul style="list-style-type: none"> • Little is known about firms that have deliberately introduced 'green' ideas into their goods and services.
Policy options for the promotion of small, 'green' enterprises	<ul style="list-style-type: none"> • SMEs have proved difficult to reach with policies regarding the provision of environmental assistance. Small firms are faced with a barrage of information, but much of it is too complex to absorb into practice or insufficiently focused to be directly relevant. • There is a raft of initiatives to assist the 'greening' of small firms, largely through management systems, process and resource efficiency. Their uptake has been uneven. Even fiscal intervention, such as subsidies for installing management systems, has had little impact. Enterprises appear to be receptive to cost saving measures, such as improving eco-efficiency through process optimisation and waste reduction. 	<ul style="list-style-type: none"> • There has been little effort to stimulate product or service innovation in a small firm context, or from an environmental perspective. • Market transformation policies are favoured politically, but it is not known how they may affect small businesses, or what kind of intervention would favour the diffusion of 'green' products from a small firm perspective.

Chapter 3. Methodology.

"The function of research is not necessarily to map and conquer the world but to sophisticate the beholding of it."

Stake, 1995.

3.1. Introduction.

The aims of this chapter are to identify the areas of the study and outline and justify the approaches adopted. The structure of the chapter is represented in Figure 3.1.

The literature review revealed that considerable effort has been directed at stimulating or coercing industry to move in a more sustainable direction. Little attention has been given to small firms that have responded positively to environmentalism beyond process optimisation. The literature also indicated that growth oriented firms, post-start up may undergo organisational changes to manage innovation, expansion and development, which can be crucial for ensuring the survival of the enterprise.

It is envisaged that this study will contribute to a theoretical framework of innovation, and provide policy makers and SME support agencies with a body of knowledge to draw upon for future policy initiatives. The literature review revealed a broad spectrum of issues, such as innovation, SME policy and environmentalism. Little, if any research, combines all those aspects in a coherent, holistic study. There have been many studies reported in the literature review on the subject of small businesses, but none attempted to combine the areas proposed in this study. The overall aim is to provide a better understanding of 'green' SMEs. For example, research has investigated the reactions of SMEs to environmental regulation, or the role of management systems, and occasionally combined one or two separate facets. This research arises from the key areas of research outlined at the end of the preceding chapter, and aims to connect several aspects. Figure 3.2 reflects this approach to the research.

Figure 3.1. Structure of Chapter 3.

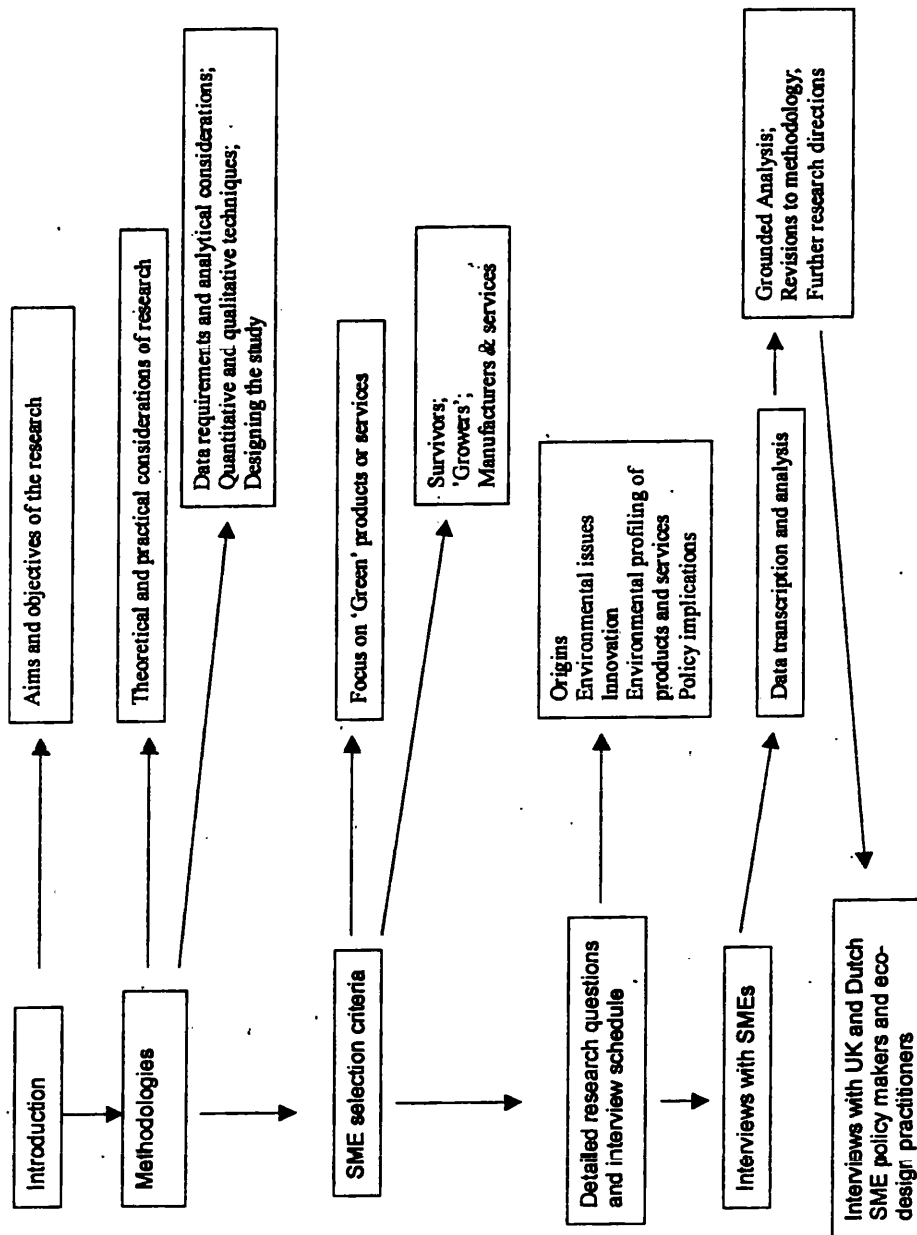
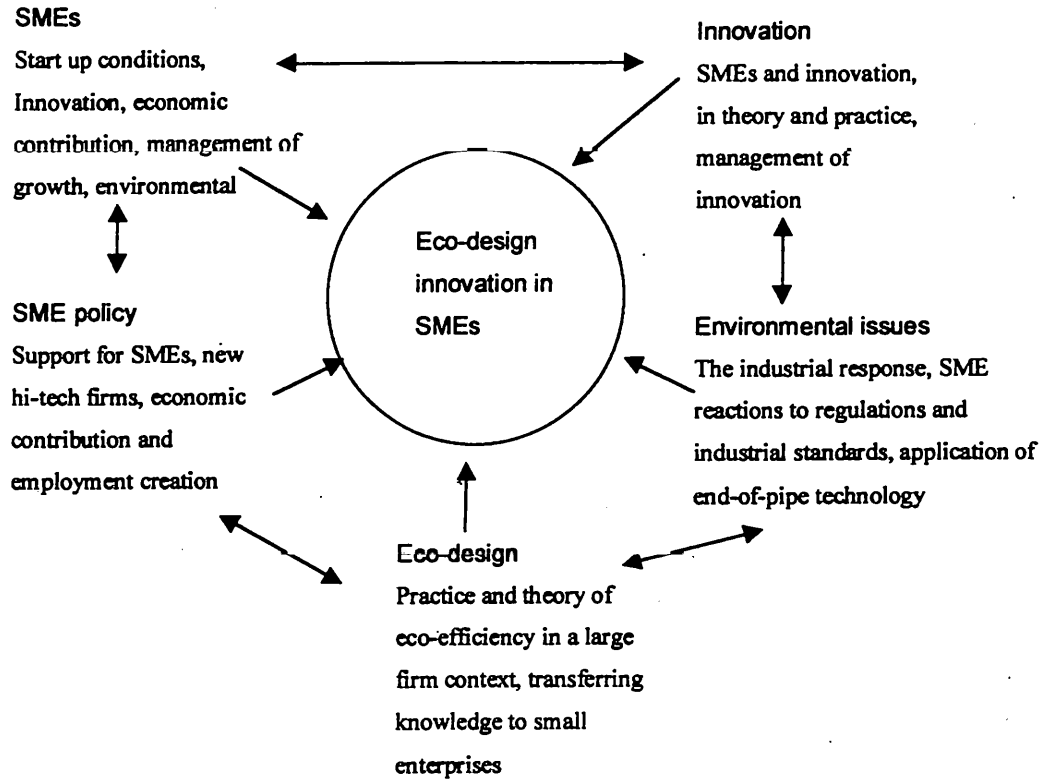


Figure 3.2. Combination of Research Areas.



The research literature suggests that these areas have been partially explored, but no work combines how environmentally inspired innovation relates to small firms, or the role of regulations in this process. The project aims to explore these diverse elements to identify appropriate policies for supporting existing 'green' firms and stimulate further eco-innovations in those enterprises. It is not intended to be an examination of the entrepreneurial motivation of SME owners or managers, or an evaluation of the economic and environmental impacts of eco-design strategies on industrial development on a macro-economic scale. Similarly, it is not intended to add to the number of manuals designed to deliver environmental management systems or eco-design solutions directly for interpretation by SMEs.

Figure 3.2 suggests that this research form a gestalt view of SMEs where the whole picture will be different from the component parts. This project is concerned with providing insights and developing knowledge of SMEs. The intention is to provide research for the benefit of government initiatives and financial investment strategies in the SME sector, such that appropriate support can be directed to encourage further eco-design products or services. The firms that pioneer such technologies have great economic future potential.

Such firms are sources of:

- Producing innovative eco-design solutions
- Producing innovative 'clean' technologies and production processes
- Providing some of the services or products in an eco-efficient economy, e.g. through recycling, repair, refurbishment, extending product life, upgrading.
- Introducing services designed to replace products.

The issues that demand proper study have been highlighted in the preceding chapter, and frame the research methodology.

3.2. The Methodological Framework.

This section of the chapter will outline the following points:

- The methodological framework
- Quantitative and qualitative data
- The case study method
- Formulating the project design
- Refinement of the methodology
- The application of grounded theory

There are many research methods available. The nature of this research needed a technique that was compatible with the investigative and exploratory nature of the research. Hammersley (1999) summarised the main attributes of experimental, case study and survey empirical methodologies.

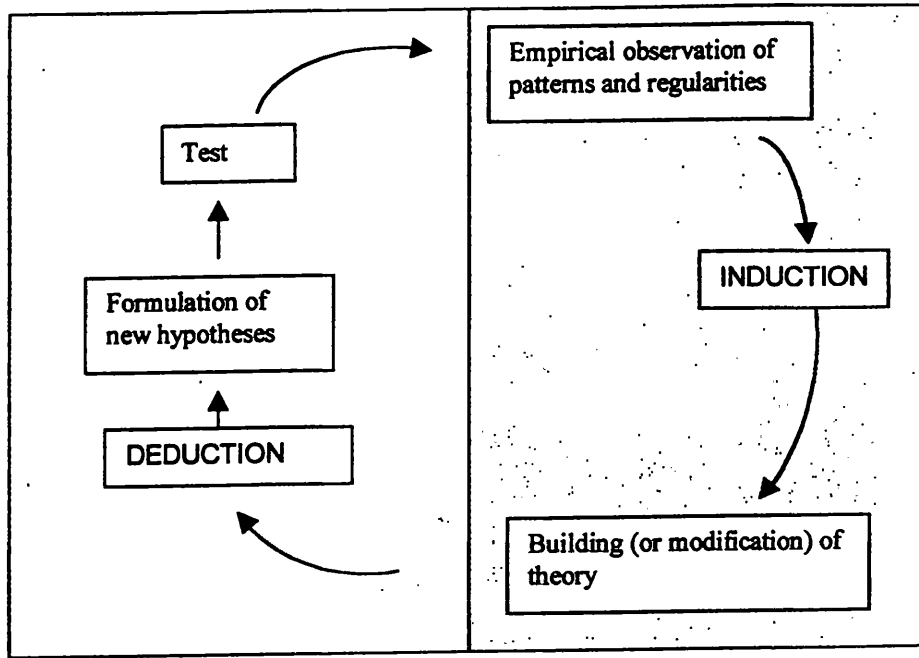
Table 3.1. A Schematic Comparison of Experimental, Case Study and Survey Techniques.

Experiment	Case Study	Survey
Study of created cases	Study of naturally occurring cases	Study of naturally occurring cases
Investigation of a relatively small number of cases (usually at least two)	Investigation of a relatively small number of cases (can be just one)	Investigation of a relatively large number of cases
Information gathered and analysed about a number of features of each case	Information gathered and analysed about a large number of features of each case	Information gathered and analysed about a small number of features of each case
Main focus is on behaviour and its explanation	Focus may be on behaviour and/or on perspectives, experiences, attitudes etc.	Focus may be on behaviour and/or on perspectives, experiences, attitudes, etc.
Quantification of data is a priority	Quantification of data is <i>not</i> a priority. Indeed, qualitative data may be treated as superior	Quantification of data is a priority
The aim is theoretical inference: the development and testing of theory	The main concern may be with understanding the case itself, with no interest in theoretical inference and/or at empirical generalisation. Possible with several case studies	The aim is empirical generalisation, though perhaps seen as a basis for theoretical inference

Source: Adapted from Hammersley (1999).

A study of this nature demands a flexible, organic, non-restrictive method, rather than a positivist approach as exemplified by the scientific, experimental method described by Popper (1968). It is therefore in the tradition of a non-positivist approach since there is no formal hypothesis being tested. This study addresses part of the hypothetico-deductive philosophy of science, where inductive reasoning complements hypothesis testing. The method is outlined in Figure 3.3.

Figure 3.3. The Hypethetico-Deductive Method of Theory Formation.



Source: Adapted from Malim et al. (1992).

In effect, this theoretical model suggests that research and theory stimulate one another through a process of induction and deduction. These are summarised and presented into a coherent whole. Deduction involves deriving testable statements, or hypotheses, from a theory. The process is cyclical and self-perpetuating, since theory is refined from continuous empirical observations, and theory is used as a guiding framework for systematic research. It follows that this project exists in the domain of the inductive mode of enquiry, represented by the right hand side of the diagram.

The characteristics of the deductive, scientific form of enquiry are that quantitative data are a priority for testing theoretical models, usually based on limited numbers of variables in controlled, artificial conditions. Langrish (1988) compared positivism to examination of physical systems, where the purpose of research is to reach universally applicable truths. By choice and constraint this study occupies the inductive reasoning area of the theoretical model. This will involve observations made to identify patterns, singularities and regularities obtained from qualitative data.

3.3. Quantitative and Qualitative Data.

Quantitative and qualitative data are embedded within the same philosophical hypothetico-deductive framework illustrated above. They are often regarded as mutually exclusive, but are part of the same loop. Halfpenny (1979) defined the two types of data;

- Quantitative = hard, numerical, objective and rigorous
- Qualitative = soft, subjective and speculative

Quantitative data, characterised by the left-hand side of Figure 3.3, yielded from positivist experimentation can be subjected to conventional parametric or non-parametric statistical analysis. Positivist research is a scientific form of experimentation designed to formulate and empirically test a hypothesis under controlled conditions. The systems can be manipulated to restrict the number of variables under investigation (Popper, 1968). Quantitative data has a predictive capacity. The reduction of errors or bias demands what Eisner (1993) referred to as 'ontological objectivity'. This implies that research aims to reveal features undistorted by views of society, although Eisner (1993) doubted that such pure objectivity existed. Reductionist techniques, being subject to replication, have this advantage. The other aspect concerns procedural objectivity that aspires to eliminate personal judgement.

In this study, a strictly quantitative survey had been rejected in favour of a qualitative, epistemological, inductive approach (Hammersley, 1992). Qualitative information can also be quantified, because data can be enumerated, transformed and coded to recognise and describe differences. Conversely, quantitative data can also be descriptive, and both forms are not mutually exclusive. A social science study, such as that of small businesses, may introduce questions about both quantifiable and qualitative issues. Aspects of financial performance can be determined from quantitative information, while attitudes to aspects of commerce can be elucidated from loosely bounded or undelineated questions. This style of investigation may be iterative, and allow the inquiry to evolve as the study progresses. The arguments about the suggestion that qualitative and quantitative data are mutually exclusive have tended to reflect the style of research.

The scientific, reductionist method complements the inductive model (Brannen, 1992; Hammersley, 1992). Hammersley (ibid) noted that most research moves between the two forms, as a quantitative experiment may arise from a qualitative theory, and vice versa. Further, Brannen (1992) argued that a qualitative approach was useful for investigating groups that may be under-represented in quantitative surveys, although their opinions and beliefs may be valid. This seemed particularly apt for this study of small firms that had expressed environmental concerns through their products or services and virtually ignored in past research.

The criticisms of qualitative data have arisen because of questions of the thoroughness of information collection, objectivity of the researcher and the ability to generalise from the findings (Brannen, 1992; Schofield, 1993). The qualitative method cannot be subjected to the same tests for reliability and validity as a quantitative experiment, but internal and external validity is still central. Schofield (1993) argued that generalisability was a characteristic of quantitative research. When applied to qualitative research, a more appropriate term is 'fittingness', or the degree to which a situation studied matched others. A technique for increasing the validity of qualitative data is through a process of triangulation. This is particular importance to this research that intends to inform 'green' SME policy. It was necessary to identify sufficient congruency amongst the cases to enable consistencies in requirements such that informed policy intervention can be generated.

3.3.1 Triangulation: Increasing the Validity of Data.

Triangulation involves verifying information. Scientific experiments can be replicated, but social science projects demand other forms of verification to reduce the chance of misrepresentation and misunderstanding.

According to Stake (1995) this can take several forms:

- *Data source triangulation.* This is used to identify changes in the phenomena studied, or if it remains constant in other places at different times.
The data reflects the complexity of SMEs. The consistencies revealed in this research suggest there are policy requirements common to SMEs in general, and some that could specifically assist 'green' firms.
- *Investigator triangulation.* This entails the use of other researchers investigating the same phenomena.
The preliminary results and research papers that resulted from this study as it unfolded were presented at various conferences and specialist audiences to confirm the reliability of the information
- *Theory triangulation.* This reveals if other interpretations of the data from other theoretical perspectives are also valid.
The conferences attended also assisted in verifying the underlying theoretical issues, and confirmed the dominant driving force is eco-efficiency. The labelling firm that forms one of the project's case studies focused on packaging waste reduction which led to a product redesign initiative. This follows the trend illustrated by rise in popularity of waste minimisation clubs (ETBPP, 1997).

From considerations of the type of information required, it is now useful to explore the techniques for data collection.

3.4. The Case Study Method.

Case studies are suitable vehicles for research that asks how, when and why questions to illuminate a set of decisions in a contemporary, real-life context (Yin, 1994). Their defining feature is that they are able to encompass quantitative and qualitative data, and can be used singly or complementary. Yin (ibid) defined case study as;

"An empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used."

The last point is relevant to this study, as it employed a variety of data sources.

Case studies are analogous to what Langrish (1988) termed naturalism, or the biological study of an organism. They can celebrate the differences between apparently similar entities, and therefore provide interesting insights (Stake, 1994). Stake (1995) also argued that case studies represented three types of systems;

Intrinsic, where the case itself is of interest,

Instrumental, where the aim is to accomplish or understand some particular factors,

Collective, involving co-ordination between a group of individual studies.

This study would entail a mixture of intrinsic and instrumental factors. The firms were selected because of some specific characteristics, and their experiences could be extrapolated to guide some aspects of eco-design and small business policy. Yin (1994) summarised six categories of information sources that can contribute to a case study. These are listed summarised in Table 3.2, shown overleaf. Case studies are different from the scientific method or survey techniques because they are not bound by the same rules of sampling, rendering traditional statistical analyses obsolete. Case studies address issues, rather than hypotheses and it is not a passive process;

"Issues are not simple and clean, but intricately wired to political, social, historical and especially personal context."

Stake (1995).

Kimmel (1988) also viewed case study research as being not free of value judgements. Case studies draw on two forms of questioning. Information questions seek relatively neutral, independently verifiable background data. Issue questions are more probing, and can address political, emotive personal attitudes and beliefs. Issue questions can be flexible, evolve as the study progresses, and afford learning from unexpected observations. The main problem relates to what Eisner (1993) refers to as a 'straw person'. That is, the completely impartial observer is mythical, but he makes the point that observations should be as objective as possible.

Table 3.2. Information Sources for Case Studies.

1. Documentation.	Communication, for example, letters, reports, agendas Internal documents, such as proposals and progress reports Information from other studies of the same site under investigation Information from the mass media This study used a range of data, such as award schemes and databases of relevant professionals.
2. Archival	Records of services (clients) and organisations (budgets, etc.) Geographical information, such as maps and charts Lists of relevant commodities Survey data; information previously collected about a 'site' Personal records; diaries, telephone conversations, etc. The study was helped by conversations with other research groups and experts.
3. Interviews	Open ended, or unstructured Focused, or semi-structured Formal survey, or structured The main body of the study depended on focused interviews with companies and agencies in the UK and the Netherlands.
4. Direct Observation	Passive observation; formal or casual The interviews were semi-formal.
5. Participant Observation	Investigator assumes an active role. Not a feature of this study.
6. Physical Artefact	An eco-designed product It was helpful to discuss the design of a tangible object.

Adapted from Yin (1994).

3.4.1 Single and Multiple Case Studies.

Single or multiple cases may be investigated. Yin (1994) illustrated the differences between the two methodological approaches using a matrix. This is replicated below.

Table 3.3. The Case Study Matrix: Single and Multiple Cases.

	Single-case design	Multiple-case design
Holistic; Single unit of analysis	Type 1; Single case (holistic)	Type 3; Multiple case (holistic)
Embedded; Multiple units of analysis	Type 2; Single case (embedded)	Type 4; Multiple case (embedded)

Source: Yin (ibid).

The assumption is that single and multiple cases offer different design considerations, and within the two types there can be single or multiple units of analysis. Single cases can be justified in certain conditions.

These include;

- The case is a critical example; it can be used to test a significant theory
- The case represents an extreme or unique situation
- It is a revelatory case; the investigator has the opportunity to observe and analyse a phenomenon previously inaccessible to investigation.

Single cases can be useful for identifying critical issues, or is representative of extreme conditions, or can reveal unforeseen phenomena. They may reflect one set of opinions or ideas, prevalent at one particular moment, and are therefore vulnerable because they cannot be verified over time. Care must be taken to avoid or reduce the risk of misrepresentation (Yin, ibid.). Single cases, whether holistic or embedded, focus on critical, unique or revelatory instances. The holistic view provides a wide perspective of the investigation, while the embedded type moves between the overview of the larger unit and individual units where a greater degree of understanding and connection can be identified.

Multiple case studies offer the advantage of being more robust than single cases, although they require more resources and take longer to complete, but can ascertain and track changes. Replication of circumstances is possible, enabling cross-case comparisons, and the results may indicate underlying patterns or provide contrasting opinions. The analysis of multiple studies follows a cross-experiment rather than an intra-experiment procedure. Each study should be selected to predict similar results, or provide contrary results, but for predictable reasons. Common to both forms of replication is the necessity for a theoretical framework that requires specific conditions under which a phenomenon is likely to be observed (literal replication), and when it is not likely to be found (theoretical replication). Yin (1994) cautions that multiple cases should not be viewed as contributing to a generalised picture, when they are more like a series of single experiments. This study was conducted on a multiple, holistic basis in that interviews were carried out with one representative from each firm. Glaser and Strauss (1967) argued that case studies demand analysis and reflection, with subsequent investigations modified by research findings. This is a highly iterative process, capable of producing extremely dense information, and enables the identification of themes. In ideal conditions, multiple case studies would be carried out to avoid the problems associated with limited access to company personnel, or information that is in a process of change. Schofield (1993) suggested that the validity of such investigations could be improved by locating research sites that represented a 'typical' picture and by conducting multi-site investigations. This was not the aim of this project, which sought unusual firms because they were inherently interesting, and increasing the generalisability was not a high priority.

The other aspect of case studies that is important for theoretical and practical reasons is the decision to terminate data collection. This point can be determined by the researcher when reviewing the data as it is collected. It is an iterative procedure, as the preliminary analysis of data contributes to building theoretical frameworks from the material as it is collected, and enables appreciation of the emergence of patterns or themes that will not necessarily be enhanced by further research. Case studies raise some important theoretical and practical considerations.

3.4.2 Advantages and Disadvantages of Case Studies.

Yin (1994) claimed that the strength of case studies was their use for investigating contemporary subjects in real-life context. They can account for many variables from multiple sources of evidence, and benefit from the prior development of theoretical propositions drawn from observations made in single or multiple settings. Yin (ibid) also argued that although case studies cannot be subjected to the same analytical tools as experimental data, they still need to possess certain criteria, namely construct validity, internal validity, external validity and reliability. In response to the criticism that case studies lack the ability to produce generalisations, Schofield (1993) claimed generalisations could be made on three domains;

What is.

Typical, common, or ordinary. Awareness of idiosyncratic variations.

What may be.

Dynamic life cycle of phenomenon studied; a 'snap shot', applicable in a single case; and cannot guarantee predictions.

What could be.

Atypical cases. Not linked to ideal type, but a special site, or special characteristics.

The last point is particularly relevant to this study, which deliberately focuses on the views and opinions of an atypical, non-random selection of small firms. This does not necessarily mean all the findings can be generalised to the wider SME population, but some aspects can be adapted for the purposes of 'greening' other businesses.

There are also some methodological concerns of data collection. The first relates to the issue of conducting research in familiar territory. The researcher may have selected the area of study because of personal interest or experience, and this has both advantages and disadvantages. Burgess (1984) identified five specific aspects:

1. Familiarity of culture enables a researcher to translate observations or phrases into data that elucidates findings.
2. It enables the researcher to relate to the informants, although this can also be self-selective.
3. Knowledge of a situation can also be used to gain rapport.

4. There is potential conflict between the role of the interviewer and values held.
5. It may be extremely difficult to differentiate between observations and feelings. Total objectivity is impossible in this context.

Another important aspect of conducting research is gaining access to the subjects. Burgess (1984) regarded this as a complex process, depending on the type of investigation and condition of initial contact. In this study, the sample selection, or interviewee, within a case could be important, since the research was based on the opinions of a senior representative of a small firm who could act as a 'gatekeeper', and perceived as a reliable source of material. Burgess (ibid.) warned that 'gatekeepers' could also come to the interview with their own agendas.

3.4.3 Ethical Considerations of Case Studies.

Conducting case studies elicits many ethical considerations, notably those of confidentiality and anonymity. Kimmel (1988) argued that there is no consensus among researchers of what constitutes an 'ethical problem'. It can relate to the conduct of researchers and their subject matter. Kimmel (ibid.) identified a typology of ethical problems;

1. The individual research participants involved. There is the potential for a discrepancy in the power balance. The researcher could gain knowledge that could have undesirable effects through creating tension or anxiety in the subject.
2. The society in which the research is conducted. Research material could embarrass the subject, or even result in legal action.
3. The body of knowledge to which the results are to be included. Research into a society or organisation may uncover evidence of unacknowledged or illegal activities and organisational ineptitude.

These were important issues in this study, and the companies approached were assured that the data collected would remain anonymous. The questions asked did not refer to potentially sensitive financial or market data, these problems were effectively avoided.

Informed consent on the part of case study subjects, in this case companies, is a central requirement. An interviewee must not feel threatened, and has the right to withdraw at any stage. The interviewee must also be adequately informed about the exact nature and purpose of the study, and be aware that it is entirely voluntary. The right to privacy and anonymity of the subject is essential (Kimmel, 1988), and the data collected should be treated as confidential. This project offered these guarantees as conditions of the research.

3.4.4 Rationale for Selecting Case Studies.

The purpose of this project was to identify attitudes and actions regarding several key areas of interest in specific kinds of small enterprises. A series of cases, such as in-depth interviews would reveal more useful insights than a broad survey. Case studies do not have to be statistically representative of a known population, but can be selected because they are intrinsically interesting (Stake, 1994), or represent 'best practice'. This study exemplified this aspect by concentrating on 'green' businesses. Case studies can convey details of complex phenomena that are beyond quantitative methods, and capable of producing rich explanatory data and potential for learning (Stake, 1994; Yin, 1994). The principal aim is to maximise understanding from a study. Generalisations can arise within and between cases if they are repeated. Content and textual data require interpretation, and provide a framework for comparing different cases (Murray and Ozanne, 1991). Case studies also offer the opportunity of developing action research projects. This can be viewed as a legitimate intervention of the observation process by the researcher. It is closely analogous to critical research, which Murray and Ozanne (1991) propounded as an approach to solving problems and precipitating change, also strongly advocated by Welford (1997) as a means of improving social and environmental conditions. Interviews can provide an empirical examination of social structures and processes examined with a dialectic process to identify contradictions and inconsistencies. The process is similar to action research (Kemmis, 1993), where the subject under investigation becomes the focus for intervention and change. In this instance, there is a close, or reflexive relationship between the researcher and the subject being studied.

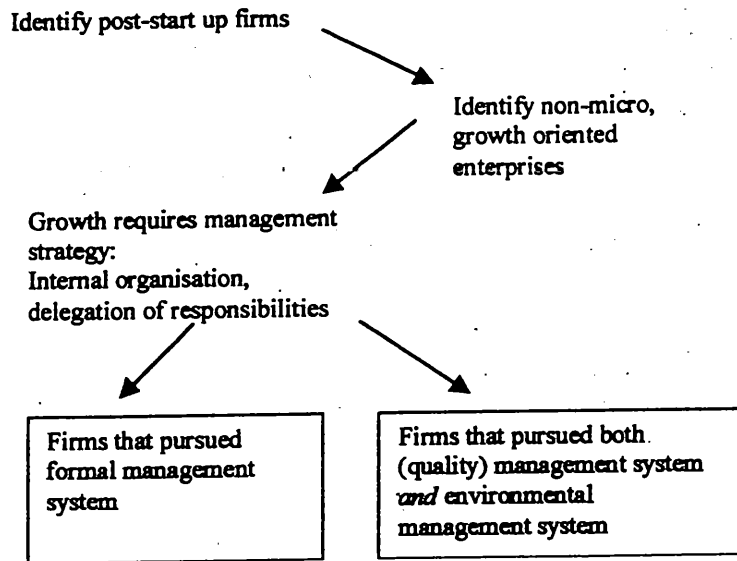
3.5. Formulating the Project Design.

The initial research process began with a survey of secondary sources of data, including the academic and business literature and discussions with other researchers in the fields of small businesses and environmental issues. The views and opinions of other researchers were vital for the formulation of the eventual research project.

3.5.1. The Initial Project Design.

The review of the literature on small businesses and the management implications of growth suggested that this was an important area of research, and one was one of the main distinguishing characters of strategically oriented enterprises. The areas for investigation (see Chapter 2) also identified that for enterprises, the early years of trading were problematic. New businesses had access to assistance, both financial and in terms of advice, to help them survive. Despite such help, many firms cease trading within the first three years. This suggests surviving or mature firms are likely to be more interesting for a number of reasons, such as their prospects for growth. The work of Gray (1995) suggested that the process of growth in SMEs presaged management decisions that demanded internal organisation and delegation of responsibilities. This pressure may also be matched by external forces, such as the pursuit of recognised management standards imposed by suppliers and customers. The introduction of formal management practices, such as BS5750 or ISO 9000 may also enable further growth and development. The presence of a quality standard may also indicate willingness or need to pursue an environmental management standard. This represents a further step in business development. The theoretical approach that combines post-start up and management issues is outlined in Figure 3.4, which shows the early iterations of the project. The initial ideas centred on identifying small, independent firms that had been trading for at least three years to exclude the possible masking effects of business start-up support. Business directories, such as the FAME database of UK companies (FAME, 2000) coupled with the DTI Quality Assurance register (DTI, 1997) was used to locate firms that had obtained the TQM (BS 5750 or ISO 9000) standard and fulfilled the other criteria. The DTI register was particularly useful because it listed firms by business sector, supplemented with codes to identify different types of certification.

Figure 3.4. Initial Project Design.



At this stage, it was believed that standards would be a useful proxy indicator for growth and potentially infer the innovative capacity of firms. It was assumed that a firm would install a recognised TQM standard before an Environmental Management System (BS 7750 or ISO 14000 series). An EMS, based on TQM, would indicate businesses aware of environmental issues, and possibly exposed to supply chain pressure. It could be inferred that there are different pressures on firms to comply with TQM alone, and both TQM and EMS, and there may be key differences between the two contrasting groups of firms, emphasised by the contrasting shading in the diagram. The differences could be due to the nature of the business sector or the stage of development of the business. The study might reveal the incentives that stimulated firms to register for either or both strategies, and the barriers that prevented them from doing so. It raises the possibility of interesting differences between the two sets of firms.

It was hoped to be able to contrast the 'green' firms selected with a matched group of 'non-green' enterprises to identify the effects of competition and innovation strategies. It will become apparent from the analysis in Chapter 4 that this option was unrealistic.

3.5.2 Refinement of the Methodology.

Discussions with a leading UK SME research group at Kingston University indicated that the notion of environmental management systems following from quality standards was probably incorrect. It was suggested by Blackburn (1997) that formal management systems and standards are irrelevant to most SMEs, who are sceptical of such systems, and informal quality assurance probably prevail. Further, the notions that quality management systems were generally precursors of environmental management systems or that the presence of standards automatically reflects innovation in products or services were also false. Management systems provide operational guidance and assurance, and are more process oriented. Another factor that had not been considered in the original design was that most SMEs provide services. Issues such as BS7750 are very rarely adapted to non-manufacturing industries. This indicated that the selection criteria needed to be revised, with less emphasis placed on the role of standards. In effect, this eliminated highly process intensive industries from the study, which in turn led to greater interest in products and services. To summarise the discussions with the research group:

- Industrial standards do not necessarily relate to the innovative capacity of a firm, and are almost irrelevant to service based companies.
- There may be no causal connection between growth orientation and management systems.
- An EMS may not follow from a quality system.
- EMS may only relate to process control and reporting procedures. Product evaluation is addressed through the application of LCA, an appendix to ISO 14001 (Meinders, 1997).
- The presence of an EMS does not necessarily infer that a company manufactures 'green' products, so this approach may fail to capture 'green' products or services.

These observations led to a re-evaluation of the research project. It was decided to abandon the search for 'green' products and services based on a review of management systems, although they could still be important in some circumstances. Instead, the focus turned those businesses that had already introduced green goods or services.

3.5.3 Revised Selection Criteria: The Search for 'Green' Goods and Services.

Chapter 2 outlined the evolution of eco-design from environmental technology through to sustainable design. This project makes a critical distinction between two activities that indirectly affect eco-design strategies. These are:

- Environmental technology
- Recycling

The first tends to focus on pollution abatement technologies that avoid the need for product redesign. The recycling industry can also be considered as a type of environmental technology, since the principal goal is to deflect waste from landfill or incineration, although it is a valid component of a sustainable waste strategy (DETR, 1999b). This is supported by legislation that includes packaging regulations and the landfill tax. In contrast, there is little policy or regulatory guidance covering the fledgling practice of eco-design, which embraces product systems. These kinds of industries were excluded from the criteria that aimed to identify products or services that had a reduced environmental impact.

The revised basis of the study meant applying three filters to identifying firms that would of particular interest. In brief, the criteria were:

1. Non-start up Firms.

The first factor to consider was to restrict the survey to enterprises that had been trading or operating in their sector for at least three years. This was to avoid confusion with the effects of start-up assistance provided by new enterprise programmes. This was important because few studies differentiate between new and existing firms. There are many pressures acting on new firms, and considerable attention and guidance are available to them. The various sources include private capital, such as Banks, and government sponsored agencies. In contrast, there is little provision for the long-term support of the small number of businesses that continue trading after the first few years. Surviving firms are of interest because they can reveal what enables firms to survive or flourish and the forms of support, such as training or financial assistance from which they could benefit.

2. Growth Oriented Enterprises.

The literature review suggested the types and characteristics of firms that display propensity for growth, or the pre-conditions that guarantee expansion, is far from conclusive (Storey, 1994). The growth aspirations of firms were therefore put into perspective by investigating the strategies of firms that already dealt with some of the management issues of growth and development. This was intended to eliminate the growth averse 'trundlers', and highlight more entrepreneurial and strategic business practices. In this research, growth was self-reported by the firms studied, and could have been misleading, depending on the criteria adopted to define 'growth'. This rested on the basis that firms intended to expand or increase turnover.

3. 'Green' Products and Services.

It remained to identify firms that can be defined by their 'green' products or services, rather than those that had introduced 'green' management practices. A useful starting point was the report by Smith et al. (1996) which surveyed large and small companies that had introduced 'green' products. It examined the company responses to a range of issues to understand what design and commercial approaches were adopted.

The report also highlighted some of the pressures that might encourage business to consider environmental issues, including;

- Existing or anticipated environmental regulation
- Commercial pressures or market opportunities
- Cost savings from using different materials or processes
- Innovation utilising new or improved technologies
- Internal pressure from environmental policies or staff; external pressure from campaigners, investors or insurance companies.

Source: Smith et al. (1996).

It has previously been noted that the SME research literature often fails to distinguish between manufacturing and service businesses (Blackburn, 1997). In order to reflect the importance of service based firms in the SME sector, those that had a recognised environmental dimension to their activities were also sought. For the purposes of this study, 'Green' services comprise two types:

1. The delivery of the service is a 'greener' *variant* of a conventional service. An example is a window cleaner who travels by bicycle rather than using a van.
2. The service offers a 'greener' *alternative* to a conventional service. An example would be a conservation holiday repairing footpaths in an ecologically sensitive area.

This defined the kinds of businesses sought. The problem was how to locate them.

3.5.4 Locating 'Green' Businesses.

The search for suitable businesses turned towards UK environmental awards and databases of relevant professionals. Street and Barker (1995) summarised the main UK private and government sponsored schemes that promote environmentally improved processes, management systems or reporting. One of the few schemes that recognised 'green' products was the Queen's Awards for Industry, and included Export, Technological and Environmental Achievement.

The last category was created in 1993, for which the criteria were;

"A significant advance in the application by British Industry of the development of products, technology or processes which offer major benefits in environmental terms compared to existing products, technology or processes."

Source: Department of Trade and Industry (1996b).

Other key sources of firms included consultation with two professional organisations, one of which provided a CD-ROM detailing their membership (AECB, 1997). These bodies promote companies involved in renewable energy or the construction industry, and some firms were common to both sectors. The latter included both construction products and services, such as architects. In summary, firms were drawn from databases of environmentally conscious construction or renewable energy businesses, professional recommendation or through 'Green' and 'Ethical' consumer magazines. The services were exclusively 'green' alternatives to conventional businesses. The change in emphasis of the study in favour of 'green' firms suggested that business specific information and opinions would be yielded by case studies.

3.6. Data Collection and Interview Techniques.

Interviews are a popular and useful method of obtaining research and have particular resonance with the case study method. King (1994) observed;

"It is a highly flexible method, it can be used almost anywhere, and it is capable of producing data of great depth. Above all it is a method with which most research participants feel comfortable; when a researcher tells them 'I would like to interview you about...' most people have a reasonable idea of what to expect."

There are two principle aims of an interview, namely;

- To gather information about the research topic.
- To explicate how knowledge concerning that topic is narratively constructed.

The interview procedure can be a combination of standard questions and active interrogation. The former means that the data generated is uncomplicated, behavioural, demographic or other measurable responses.

An active interview implies that the questions bring meaning and construction to the foreground, and is most appropriate when the researcher is interested in subjective interpretations (Holstein and Gubrium, 1995).

3.6.1 The Active Interview.

Historically, the conventional view of interviews is that of a passive vessel providing answers to questions, or merely as truthful, objective conveyers of reliable, valid facts (Holstein and Gubrium, 1995). If however, the interview is regarded as a dynamic, meaning making experience, different criteria apply that can construct meanings and the circumstances of that construction. The interviewee becomes more akin to narrators of experience, and the interview becomes more conversational. Contradictions may become apparent, and the position of the interviewee may shift during the interview.

The 'active interviewer' (Holstein and Gubrium, *ibid.*) is responsible for activating "a narrative production".

"The active interview is not so much dictated by a pre-designed set of specific questions as it is loosely directed and constrained by the interviewer's topical agenda, objectives and queries."

This means the interviewer intentionally provokes responses and constrains them. The active interview technique is appropriate for case studies, and two aspects of interview technique are important;

- Conditioning stories. Introductions are important, and can guide and suggest relevant ways of thinking and linking experience.
- Using background knowledge. This makes the research more productive, as it introduces the interviewer's own experience as a shared resource. Expertise gained in conducting interviews can be useful to relate experiences of one interviewee to another.

The first point relates to 'grand tour' type questions (see 3.7.1 The Interview Schedule). The second is particularly relevant within this case study context. The researcher had already gained knowledge and experience of the SME sector and was able to converse informatively. This was important in two senses. Firstly, it increased the validity of the interviews, as interviewees were able to recognise and empathise with the researcher's experience.

Secondly, the information gained from one interview could effectively inform subsequent interviews, particularly with the UK and Dutch SME support agencies. It also enabled a critical appraisal of the data during the collection process.

3.7. Interview Schedule Design and Interview Techniques.

A highly structured interview was inappropriate for this study as no formal hypotheses existed for testing. Conversely, open-ended interviews, or ‘conversations with a purpose’ (Burgess, 1984) were also considered to be inappropriate because there was a need to discuss specific aspects of the businesses. The compromise was a semi-structured interview approach. This permitted a basic framework for ease of data comparison across a number of different participants and was more cost effective on interview time than a pure open-ended method. There are different formats for interviews, briefly summarised in the following table.

Table 3.4. Types of Interviews.

Type of interview	Characteristics.
Informal, conversational	Questions emerge from the immediate context and asked in the natural course of the conversation. There are no predetermined questions or topics
Interview guide approach	Topics and issues to be covered are specified in advance in outline form. The interviewer decides the sequence and wording of questions during the course of the interview
Standardised open-ended interview	The precise wording and sequence of the questions are predetermined. All interviewees are asked the same questions in the same order
Closed quantitative interviews	Questions and categories are predetermined, and the responses are fixed. The respondent chooses from those responses.

Source: Adapted from Patton (1980).

Some of the strengths and weaknesses of the respective forms have been discussed as they relate closely to those of case studies. Briefly, the method selected for this study combined the second and third types of interviews.

This involved a standardised set of questions asked in the same order, thus increasing the comparability of responses and ensuring maximum data for the topics under discussion. It also facilitated the ordering of the information and thematic analysis. This technique had the disadvantages of little flexibility in relating the interviewer to particular circumstances, and there was the risk that the standardised wording would constrain the naturalness. In practice, these potential problems did not materialise.

The firms selected were initially contacted by a telephone call to establish if they were suitable for inclusion and a representative was willing to participate in a face to face interview. This was followed by a letter sent to the company requesting an interview with a senior member of staff, founder member or director. The introductory letter described the nature of the project and why the firm had been chosen, together with an outline of the interview schedule. It was important to gain the trust of the interviewees, and emphasise the confidentiality of the data collected and guarantee anonymity. It was stressed that the interview was not seeking intrusive or sensitive financial information, and this possibly helped the high success rate. Only one firm approached declined the opportunity to participate in the research project. The letter was followed by a telephone call to negotiate a date, time and location.

Permission was sought to record the interview conversations which allowed them to develop naturally, without the lengthy breaks enforced through having to write responses (Hammersley and Atkinson, 1995; Holstein and Gubrium, 1995). This also meant that interesting avenues could be explored more thoroughly. Although all respondents agreed to the recording of their conversations, the researcher stated that the tape would be switched off at their request at any time during the interview. At no point did any respondent request this and the recordings continued uninterrupted. All interviews were conducted on the business premises, and typically ranged from 90 to 150 minutes in duration.

3.7.1 The Interview Schedule.

The format of the interview schedule evolved in an iterative process to include five main themes, each composed of a sequence of open-ended questions. The final schedule is reproduced in Appendix 2. The schedule contained bounded, descriptive questions, combined with more probing, open-ended, issue based questions that explored opinions of interviewees. This allowed the interview to develop in a natural, but guided manner and explore interesting aspects denied by for example, postal survey.

The sections were briefly:

- 1. General Company Background.

These were 'grand tour' descriptive questions (Hammersley and Atkinson, 1995) designed to provide information about the origins, background, trading status, markets, issues on the current business agenda and future concerns and the effects of voluntary codes of practice. All these issues shape the development and growth aspirations of a company.

- 2. Environmental Issues.

This investigates attitudes towards environmental regulations and voluntary industry schemes. The literature reviewed in Chapter 2 presents a confused picture of the effects of environmental regulations and standards on SMEs. Identify and Compare the barriers and stimuli that prevented or caused progress from quality standards, environmental quality through to environmental excellence, if this process occurred. Ascertain what would encourage firms to move beyond 'excellence'.

- 3. The 'Green' Product or Service.

This examines the markets, drivers for innovation, evaluation and competitive advantages of the 'green' product or service, particularly in relation to their competitors.

- 4. Environmental Impacts of Products and Services.

Environmental issues addressed in the design of the product or service, barriers encountered and scope for future innovation. The Eco-wheel (Hemel, 1998) was used to guide interviewees through the product profile. This was an important aspect of the research, and will be elaborated later.

- 5. Support for Business.

The final part enquired about the policies available to assist SMEs. It also explores what policies would have helped them overcome specific hurdles, what is needed now and the design of future policies that would assist them. It enquired about their experience, if any, of policies they considered beneficial.

The next section addresses some of the issues and concerns of conducting interviews and collecting information.

3.7.2 Interview Transcription.

The interviews were transcribed by the researcher to include additional field notes and observations. King (1994) considered this to be a time consuming activity, but Buchanan et al (1988) recommended that researchers should type their own interviews, as this facilitates ease of understanding technical problems with the recording or interpretation of the recorded material. It also provides the opportunity to 'clean up' the interview without adding distortions. In this instance, the researcher was also able to add short additional notes, insert markers into the text and highlight suitable quotes that would illuminate a particular topic. It also provided an opportunity to observe patterns as they arose.

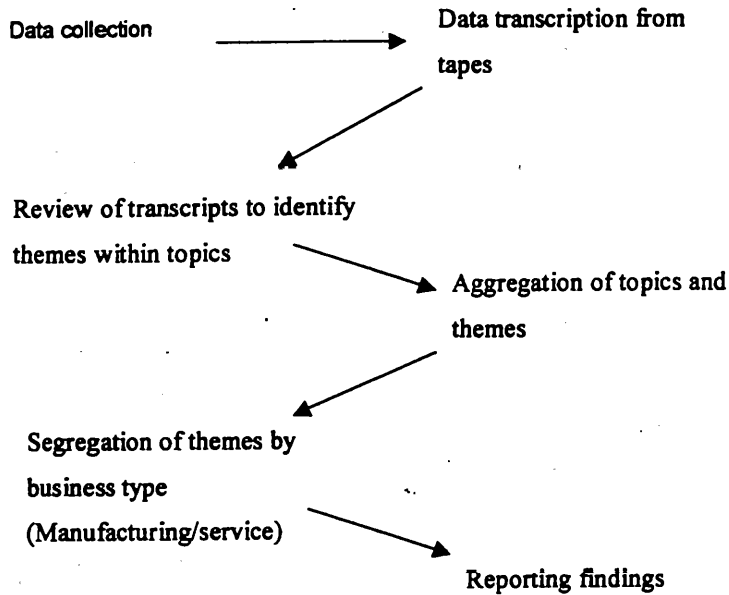
3.7.3 Analysis of Qualitative Data.

Stake (1995) believed the information yielded from interviews could be aggregated using categories to identify patterns, or from naturalistic generalisations based on personal engagement and observations. The data collected from the interviews was unstructured. That is, it was not already coded in analytical categories, but included field notes. (Dey, 1993) proposed that the structuring of data can take two forms:

- It may result from the physical control of responses, as in questionnaires, where choice is determined by the researcher.
- It may be produced by the application of a set of categories, as in the case of systematic coding of free responses to questionnaire items using a pre-determined coding scheme.

The kind of data gathered from these transcripts fits neither of the two categories, since the analytical themes and framework emerged after reviewing the scripts. The approach to the analysis can be summarised according to the following process.

Figure 3.5. The Analytical Process.



This process of identifying and analysing themes within the various topics discussed during the interviews relied on the application of grounded theory.

3.8. Grounded Theory.

The core principles of qualitative analysis lie in the related processes of describing phenomena, classifying ideas and identifying interconnecting themes. Glaser and Strauss (1967) defined the technique as;

"The process of data collection for generating theory whereby the analyst jointly collects, codes and analyses his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges."

Grounded theory is a comparative method that develops the analysis of case studies through generating categories and examining properties of the data collected, rather than testing hypotheses (Strauss and Corbin, 1990). Interview transcripts provide suitable data for generating grounded theory. The first step is to develop a thorough and comprehensive description of the information. This can provide a social, cultural, spatial and historical context using the information from the 'grand tour' type of questions (Hammersley and Atkinson, 1995).

This aids the second step, understanding the perceptions of different observers and classifying information into themes (Miles and Huberman, 1984; Strauss and Corbin, 1990). The final step is making connections with other strands of enquiry to identify singularities, regularities and variation. An important aspect of this study was that the goal was not to capture a representative sample of the general population of businesses, but continually solicit and analyse representations and meanings from a small sub-set. The small sub-set was chosen to ensure that a wide range of issues and circumstances would be covered. Grounded theory is particularly applicable to this research, as it is a comparative method for generating categories and identifying properties rather than testing hypotheses. Burgess (1984) described four stages of this method:

- Stage 1. Compare incidents applicable to each category (data coding)
- Stage 2. Integrate categories and their properties
- Stage 3. Determine the limits of theory; that is, reduce theory and delimit the saturation of categories, but ensure that the criteria used to select and delimit is checked
- Stage 4. Writing period. Analytical notes are used to guide the production of major themes for publications

The procedure is iterative, and permits the identification, evaluation and connection of themes so there is a general rationale and argument for the research. The basic tool is identifying themes using definitions, then finding links and the conditions of those links. The outcome can be used for incorporating existing theory for future testing, and feeds into the deductive loop of the hypoethico-deductive method previously described.

3.9. Preliminary Analysis and Methodological Revisions. Directions for Further Policy Research.

This section of the chapter introduces some of the issues that emerged from a preliminary analysis of the interview transcripts. The transcribed data was subjected to preliminary analysis to identify trends and themes, and used to guide further enquiries.

Each part of the interview schedule was identified by a number that indicated the section and specific area of enquiry. Corresponding markers were inserted into the transcribed text to indicate relevance to questions.

This technique allowed data to be codified for thematic analysis and for comparing responses from other interviews. The first three parts of the interview schedule proved straightforward to analyse, on the basis of the themes that became apparent (Miles and Huberman, 1984) and will be described in greater detail in the next chapter. The fourth section, 'Environmental impacts of the product' included questions about the environmental profile of products and services. Products were assessed using the Eco-Wheel as a 'Design for the Environment' analytical tool, which is further described in the following section.

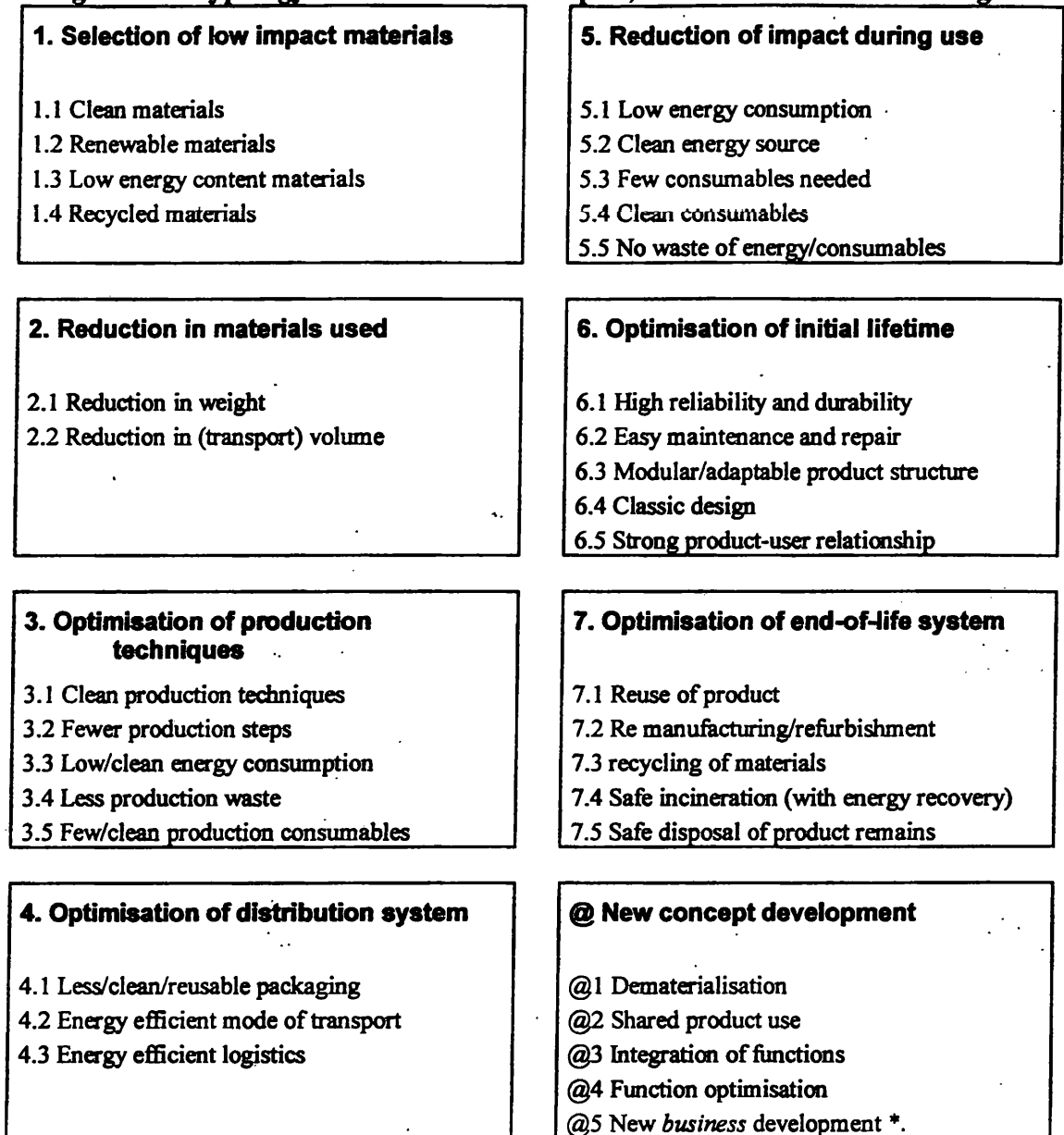
3.10. Methodological Tools.

3.10.1 The Design for the Environment (DFE) Analysis.

This part of the analysis describes the tool used for assessing the environmental profiles of products. The environmental profiling of services required a different approach, and will be discussed in Chapter 6. The 'Design for Environment' (DFE) strategy wheel developed by Hemel (1998) for use in assisting Dutch SMEs redesign products to incorporate environmental issues has been previously introduced in Chapter 2. This design tool consists of eight DFE *strategy* dimensions, each composed of between two and five DFE *principles*. The dimensions represent 'clusters' of a total of 34 related design options. The DFE design strategy typologies are summarised in the Figure 3.6.

It can be seen that the successive themes of the DFE principles follows the manufacture of a product, from the material selection through to the ultimate disposal, having taken into account the manufacturing process, distribution and environmental impacts of use. Hemel's work (1998) contains a detailed manual and guide that were used to deliver the DFE strategy options as an action research project within participating Dutch companies.

Figure 3.6. Typology of the 34 DFE Principles, Clustered in 8 DFE Strategies.

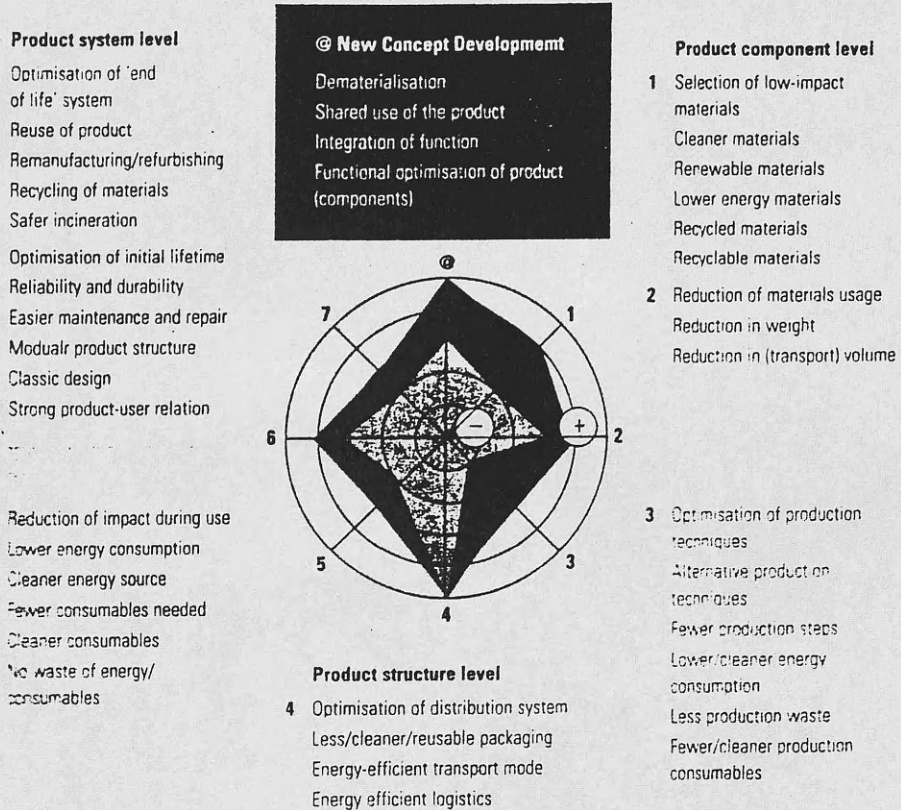


(* see the '@' The Strategic Options)

Source: Hemel (1998).

This entailed an 'eco-scan' of a firm to determine its suitability and environmental awareness prior to the introduction of eco-design principles, followed by monitoring the outcomes. The results of a scan, or review of the environmental issues addressed by this process were graphically displayed using the 'eco-wheel'.

Figure 3.7. The EcoDesign Strategy Wheel



Source: Hemel (1998)

The smaller shaded area in the diagram indicates the profile of a product before intervention. The larger, darker of the two relates to the aspects addressed through the implementation of the redesign. The strategy wheel does not represent the desired or actual environmental load, but indicates the ambitions of a company, and the aim is to make the area as large as possible. It does not necessarily correlate directly to an indicator such as the DFE score.

A methodology for measuring the extent a process, product or packaging redesign innovation initiated by the project was developed. This resulted in a compendium of four separate indicators, the DFE score, project score, design impact and result option. For example, the DFE score was derived using a 0 to 8 scale that described the extent by which a cluster had been implemented by a firm. The scale is described in Table 3.5.

Table 3.5. DFE Scores and their Meaning.

Cluster	Success Rate	Description
Rejected	0	The option had been rejected and was of no future interest to the company
Of Interest	1	The option had been studied in more depth; realisation had still been rejected
	2	The option had not yet been studied; it was assured of the company's future interest
	3	The option was still being considered; realisation was uncertain.
Prioritised	4	The option was being implemented; realisation expected within three years
	5	The option was being implemented; realisation expected within one year
	(Realised) 6	The option had already been implemented or would be very soon.
Not Considered	7	The option had not been given special attention as it was regarded as a bottom line in product development, and in the company's continued interest
	8	The option had not been studied because it had become irrelevant.

Adapted from Hemel (1998).

By conducting an assessment of the firm before and after the project, it became possible to identify the areas for DFE improvement in a 'new' product. The eight DFE clusters form a composite of over 34 different components, and can be visualised as segments of a series of concentric circles. This graphical representation was used to complete an environmental profile of a product and highlight priorities for the redesign of a product. The origin of the circle represents lowest scores, or least attention to a strategy cluster, higher scores indicate greater emphasis. The DFE strategy wheel shown below profiles an existing product and priorities for a new product.

3.10.2 Refinement of the Methodological Tools.

The eco-wheel was used in a slightly different way in this project from the original Dutch programme. The Dutch project followed an essentially action research methodology. A preliminary scan was conducted on particular products in participating firms to identify suitable aspects for redesign. The companies received several visits from the eco-design support team based at various Innovation Centres to assist with implementing design changes suggested by the DFE principles. In the Dutch project, the eco-wheel was a central feature. In this study, it was not used as a longitudinal, dynamic tool, but employed as a static, 'snap shot' to analyse a company and its products. It was therefore less important than in the Dutch study, but enabled the capture of the life cycle of a product at that time. This is a new use of the eco-wheel tool. It relied on data gathered in a single interview, because it was not feasible to conduct a preliminary scan on each product. Unlike the Dutch initiative, this was not required since the project did not propose active intervention. This was a discursive, passive approach to using the model. In addition, a streamlined version was used that lacked the detail of the original design 'clusters' because of time constraints of the interview. The general philosophy of each 'cluster' was conveyed to gauge reaction and identify areas for strategic changes. Further amendments were made to the original eight-point ranking scale devised for the DFE scores that did not reflect the themes emerging from the interviews because in its original state the eco-wheel related to design *improvement* options. The revised scale is described in greater detail.

An alternative system was adopted to allow the respondents to identify how important each component was and the potential for improvements. The interviewees were asked to give each DFE strategy an overall rating on a scale ranging from zero to five. A score of zero meant that the firm had not considered the issue in relation to a specific product. A score of five represented the other extreme, where in the opinion of the interviewee the option had been implemented to its maximum current potential. This obviously led to highly subjective values, and invalidated any comparison between firms and products. It was useful for indicating areas of concern, action taken and future design options. Detailed analysis of the transcripts revealed information that enabled more structured coding of each element, similar in nature to the original eight point DFE scale. A six point ranking scale emerged from a review of the transcripts. A score of 0 indicated that the DFE strategy was not mentioned, while a score 6 showed that the firm had committed considerable resources to addressing the issues. The revised coding convention is summarised in Figure 3.6.

Table 3.6. Revised DFE Principles and Significance.

DFE Principle Rank	Significance
0	Not mentioned or inappropriate.
1	Aware, but very low priority, nothing yet achieved, possibly action planned in the future.
2	Aware, but no action taken for reasons other than environmental factors (e.g. lack of R&D.)
3	Limited action taken because of possible negative environmental consequences (potential 'trade off'.)
4	Some action taken and more planned. More scope for improvement if conditions change. Outcome could be driven by non-environmental considerations. Low cost, low benefit actions.
5	Considerable resources committed, much activity.
6	Fully committed and explored issue within limits of current technology. Future developments in this area expected.

The revised six-point scale was used to compare the respondents' own assessment to a more detailed analysis of the individual components of the eco-wheel, identifiable from the interview transcripts. The tabulated analysis of the DFE principles is shown in Appendix 3. Quotes drawn from the transcripts will be used to illustrate how the different scores were interpreted in practice for products in the Chapter 5. The scale was further refined for application with the services, and will be described in Chapter 6.

3.10.3 The '@' Strategic Options.

The final change made to the use of the eco-wheel concerned the final set of strategic options, assigned '@' by Hemel (1998). This was used to describe 'new concept developments'. In the original model, Hemel (ibid.) drew a distinction between new *concepts* and new *business directions*. She used a separate category, 'DFE actions' that referred to the total product range and covered more general DFE-related topics such as managerial, legislative or market issues. These have been explored in detail in other sections of the interview schedule devised for this study. New concepts involve firms focusing on new strategies to deliver existing needs from an environmental and functional perspective.

This questions the function and needs fulfilment that underlies the product systems, and seeks to find alternative, less damaging alternatives. These are synonymous with the level of 'function innovation' envisaged by Brezet (1997). An example of DFE @ option 1 (Dematerialisation) is the improvement in electronic communications systems provided by the internet and Email that enables the transportation of information. Adoption and diffusion of these technologies have the potential capacity to reduce the impacts arising from transport and the use of paper. In this study, the category '@5' was created specifically to allow firms to explore new business direction ideas, often involving adaptations of existing product lines. For example, if the underlying technology is robust, it could provide platform for new products.

The methodology proved to be suitable for analysing the product based firms, but inappropriate for addressing the environmental considerations expressed by service enterprises. The interview experience of using it in this study showed that while the eco-wheel was useful for visualising tangible products, the environmental dimensions of services could not be captured by this method. The analysis of services demanded a new way of dealing with environmental profiling. The revised methodology will be described more fully in Chapter 6.

Analysis of the themes that emerged from the other sections of the interview schedule revealed some common concerns of the firms. These insights informed further interviews with small business support organisations and agencies in the UK and informed a review of Dutch SME innovation and eco-design policies and activities. The results of the later interviews, conducted between July and December 1998, are reported in Chapter 7.

3.11. Business Profiles.

Fourteen firms were identified as suitable subjects for this study, and were interviewed between September 1997 and June 1998. The firms that participated in this study are summarised below. They have been given pseudonyms that reflect their business activities and guarantee anonymity.

1. Solar Tech.

This company was originally a plumbing and electrical business based in the midlands. Following the hot summer of 1976 the owner recognised a potential market for passive solar heating panels. Their products, which are used for pre-heating domestic hot water, are both robust and reliable. In use they displace a limited amount of energy derived from fossil fuels. They plan to expand into the production of other forms of environmental technology.

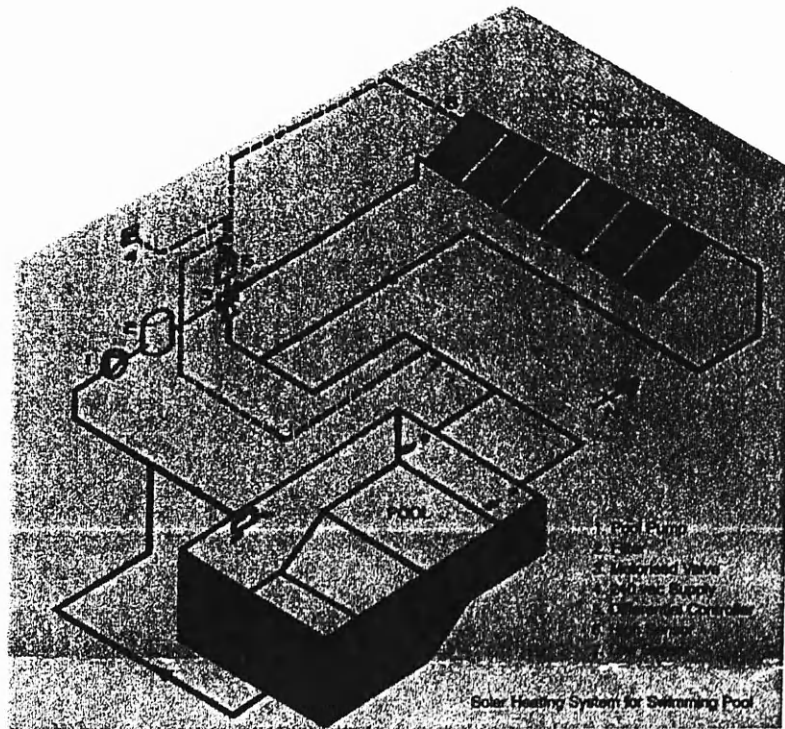
2. GreenStick.

This interview was unusual, as it was with the Managing Director of a company that had attempted to effect the redesign a product with the intention of maximising resource efficiency and reducing waste output. The company manufactures labels for plastic containers for goods such as toiletries and cosmetics, and is likely to be adversely affected by new packaging regulations. Although the resultant product had not proceeded to production, the project demonstrated how a small actor in a supply chain could influence major design decisions that had significant organisational, environmental and financial consequences.

3. Solar Splash.

This company has a background of engineering and working with plastics. The company bought a firm that specialised in the manufacture of solar heated outdoor swimming pools, using similar technology as Solar Tech. The benefits are very similar, as the panels effectively lengthen the useful season of outdoor pools and reduce dependency on conventional fuels. Although the system is inappropriate for providing domestic hot water, it is suitable for other novel applications, such as supplementing conventional heating for an outdoor swimming pool. The system is illustrated in Figure 3.8.

Figure 3.8. Diagrammatic Representation of Solar Heating System for an Outdoor Swimming Pool.



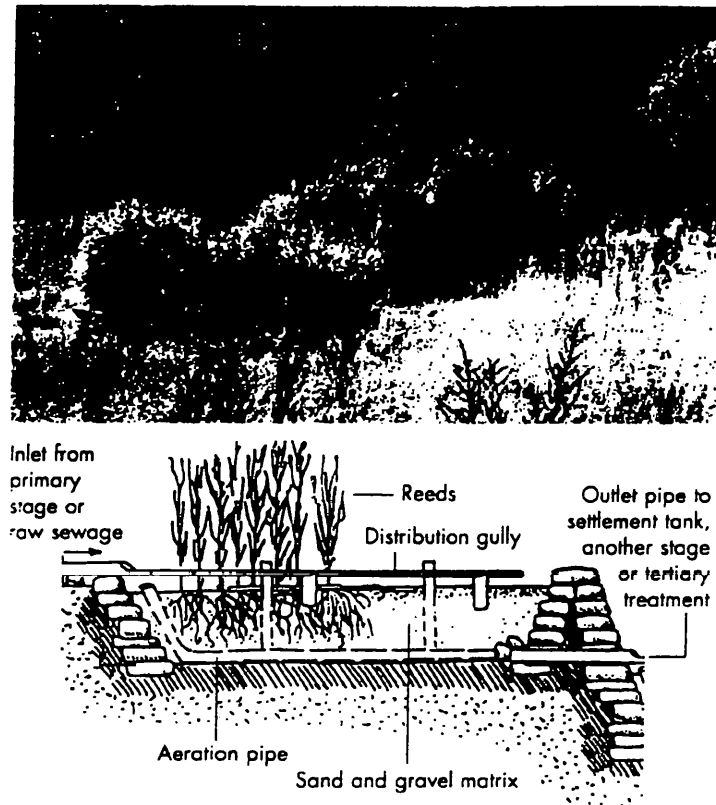
4. EcoBatts.

This south coast based firm manufactures rechargeable dry cell batteries, largely used in industrial applications where high quality and reliability are premium design requirements. Use of their products obviates the need for some types of disposable batteries. Their products are energy efficient and technically superior to alternatives. The design provides a technical base for allied lighting products.

5. Fresh Water.

This is a recently established partnership, drawing from the owners combined experience in the area of water treatment. The business developed from mutually shared interests in the use of reed beds as an alternative, low impact technique for treating sewage. This in turn has developed into consideration of water treatment and conservation technologies using alternative technologies. An example of how reed bed technology works is shown in Figure 3.9.

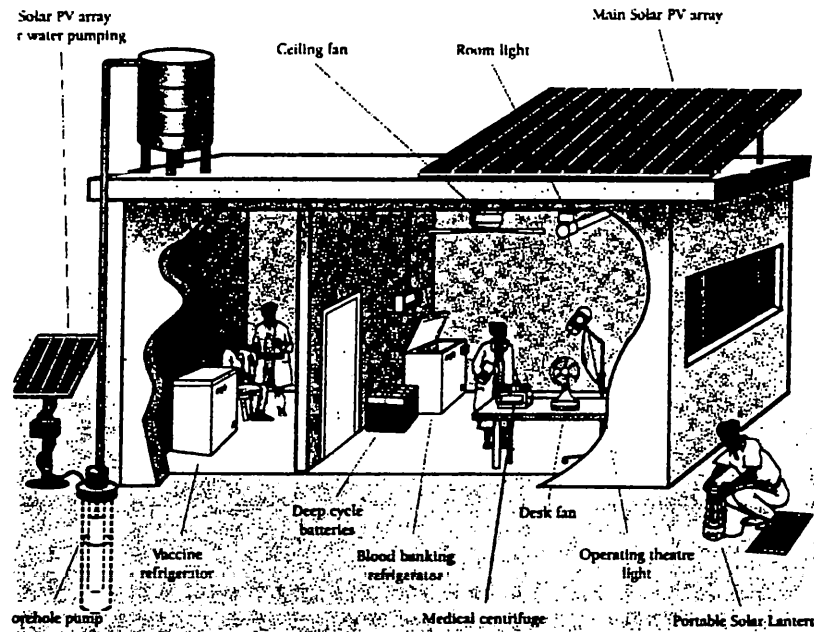
Figure 3.9. Illustration of Reed Bed Technology.



6. EcoChill.

The firm operates as a small scale co-operative that has emerged from a tradition of working in various renewable energy technology projects that includes solar, wind and water. This interview focused on the production of a photo voltaic (PV) powered refrigerator designed for transporting medicines in developing countries. The design uses a 'clean' energy source and is extremely well insulated. The refrigerator forms part of a system that extensively utilises renewable energy resources, as show in Figure 3.10.

Figure 3.10. Medical Application of a Solar Powered Refrigeration System.



7. Green Info.

This Pennines based company grew from the owner's considerable experience of producing corporate and industrial films. The video production market has become extremely competitive as the cost of technology has fallen, which led the owner to explore potential future markets. He concluded that environmental issues would eventually become important to business, which would need training material in relevant aspects. The firm produces two kinds of videos. Generic videos focus on particular legislation and are sold to mainly to larger firms. The rest of their business is derived from bespoke videos produced for individual clients.

8. GreenAcres Building Society.

This is a small Building Society in the north of England that specialise in providing finance for building renovation and unorthodox construction techniques that demonstrate strong environmental thinking.

9. GreenBuild.

The interviewee is an architect based near the Welsh border who co-operates with a network of like minded 'associates' to design and build environmentally sound and energy efficient houses.

10. EcoBuild.

In common with GreenBuild, this architect operates on a similar base, and has a reputation for designing low energy buildings.

11. Enviro Shop.

Interview conducted with the proprietor of a unique combination of a shop that specialises in the retail of 'green' products, such as environmentally friendly paints, and a car repair service. The shop acts as a demonstration of the potential for environmentally sound building construction and operation, and the whole enterprise reflects the owner's personal interest in sustainable development.

12. Eco Word.

This firm specialises in publishing journals and books that concentrate on environmental management and strategic issues aimed at business and academic audiences. The subject of the interview was a discussion of a book that focused on the limits of eco-efficiency.

13. Enviro Loot.

This interview was conducted with a representative from a network of consultants that specialise in providing clients with advice on ethical and environmental investment.

14. Greencar Rescue.

This company was launched as a 'green' alternative to the AA and RAC, and provides a similar function. They provide insurance policies designed to cover all road users, including cyclists. Unlike the AA and RAC, they do not directly employ their own vehicle recovery trucks, but franchise the operation to garages.

3.12. Summary.

This chapter has reviewed the methods of research, and identified case studies as the most appropriate for providing answers to five areas of interest that arose from the literature review.

The research sought to identify appropriately designed assistance to encourage firms that are receptive to external support incorporate eco-design thinking, from a product or service perspective, within their business practices. The novel aspects of this research are the focus on those firms that are growth oriented, established, exploiting a particular 'green' technology or market, and are seeking to expand. The key feature of the project is to identify policies that are intended to support existing 'green' firms, and stimulate further 'eco-innovation' in those firms. The research programme included in-depth interviews with firms that have already made significant progress in 'greening' their products or services. This was done to determine what barriers they had to overcome, and what would stimulate further progress. The aim was to guide policy initiatives designed to support SMEs. The interviews with businesses were supplemented with interviews with SME support agencies and policy makers in the UK. Further work was conducted in the Netherlands, which had already implemented an ambitious programme of fostering innovation in SMEs, with the aim of identifying suitable policies that could translate to the UK situation. This concludes the methodology. The analysis of the interviews will follow over the course of the next four chapters, starting with the company backgrounds, environmental issues and innovation. The second will assess the environmental profiles of the products studied. The third includes the revisions to the eco-wheel approach demanded to describe the environmental impacts of services. The final chapter of the four reports on the investigation of the policy issues highlighted during the company interviews and includes an analysis of UK and Dutch eco-design strategies.

Chapter 4. Analysis: Background, Environmental Issues and Innovation

4.1 Introduction.

This chapter presents the information collected in the first three sections of the questionnaire. The first part sought to identify various general business issues within the sample of firms. Particular emphasis was placed on their strategic decisions and options for future development, both for growth and technological or service development. The second part of the questionnaire investigated the wider environmental concerns of the firms and their approach to regulations and voluntary initiatives. The final section dealt with the innovation process and product or service evaluation and competitive advantage. For the analysis, the issues have been split into four sections, grouped thematically, and deal with the business environment, growth strategies, environmental issues and innovation respectively. The structure of the chapter is shown in Figure 4.1.

4.2. The Business Environment.

This section is further subdivided into, in sequence origins and markets, recent developments in industry and other industrial trends and UK government activity that has affected the sector.

4.2.1 Origins and Markets. Services for 'Metagrumblers'.

This part addresses the background of each business. All firms except Fresh Water had been trading for over 6 years old at time of interview. The founders of this particular partnership had gained considerable previous experience of alternative, low-technology sewage treatment techniques, which enabled them to establish their own business. The ownership structures are shown in Table 4.1.

Figure 4.1. Structure of Chapter 4.

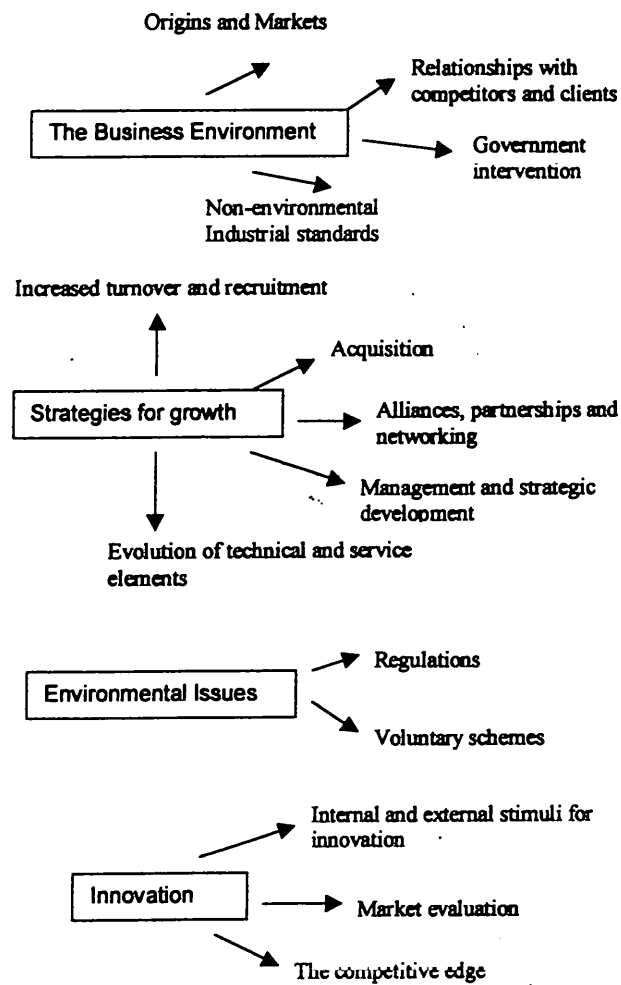


Table 4.1. Ownership Structures of the Firms Surveyed.

Form of Ownership	Number
Privately owned/Limited Company	7
Co-Operative	1
Associate Membership Network	2
Group of Companies	1
Mutual Society	1

Most of the firms interviewed are small, with fewer than 20 employees. Just two, Solar Splash and Green Stick have more than fifty. The latter is part of a larger group of companies, employing some 110 people. In practice, all the firms operate as non-micro scale enterprises, and emulate larger scale businesses in different ways. This will become apparent when discussing their different growth strategies.

The roots of the businesses are diverse. Of the two firms that developed products that harness solar energy for heating water, the director of one realised the commercial potential of this renewable resource during the hot summer of 1976 which coincided with the effects of the mid-1970s oil crises. The other firm bought out an existing business that complemented their own competencies in moulding plastics. They were aware of the contribution to both profits and turnover the business would make as they supplied the components for the solar heaters. In contrast to this proactive strategy, the label printing firm, GreenStick, was forced to resolve the potential threat of environmental legislation affecting the packaging industry, and they chose to negotiate an innovative solution with their supply network. This will be described more fully in 4.4.2 (Environmental Regulations) and 4.5.6 (Barriers to Innovation). EcoBatts was prompted to develop an efficient, rechargeable battery, largely because of the managing director's abhorrence of waste, particularly energy. Fresh Water extended the idea of environmental technology to embrace the philosophy of finding solutions for water conservation, rather than selling a technique or technology. They also have an active interest in renewable energy sources. EcoChill emerged from a highly specialised background in solar, water and wind power technologies.

The service companies generally provide 'green' variations of existing services. For example, the video training firm, Green Info produce packages with a strong environmental theme. Similarly, GreenAcres Building Society and both architect practices specialise in non-standard construction techniques. They provide 'green' alternatives to mainstream providers and exploit potential or suspected markets, or build on existing demand. They fulfil a niche demand in larger markets.

Most of the 14 firms in this survey sell their products to more than one type of client, reflected in Table 4.2 that summarises business relations.

Table 4.2. The Enterprises and their Clients.

Nature of Client	Number of Firms
Other Businesses	9
Direct to end user	7
Government Agencies/ Non-Governmental Organisations (NGOs)	3
Professional Organisations/Academics	2

Three of the firms also export their products. EcoChill alone depend exclusively on exporting the solar powered refrigerators to overseas agencies, notably the World Health Organisation (WHO). Other firms that rely in part on exports include both the solar panel manufacturers. The services deal with individuals that are probably atypical of the general population. For example, the interviewee at Greencar Rescue described their clients as;

“Our members tend to be metagrumblers.”

This was interpreted as people who are financially stable, or affluent self-selecting environmentalists, able to exercise a high degree of choice in their purchasing habits. The next part of the chapter investigates how general changes in relationships with clients and other competitors, government intervention, industry-wide changes and non-environmental industrial standards have shaped these businesses.

4.2.2 Relations with Mainstream Competitors and Clients.

This section explores how the firms interviewed regard their relationship with largely ‘non-green’ competition, how they hope to influence their clients, and in turn how public pressure is affecting some businesses. There is evidence that the firms studied are enthusiastic about influencing non-green business practices. One aspect of this is the need to gain credibility and professional recognition rather than collecting ‘green’ credentials or awards.

For example, Fresh Water felt it more useful to gain acceptance within traditional professions;

"Because for us, what we're doing has almost inherently got a green image, we don't have that (AECB Award) as a priority...for us it's more a thing to join the Institute of Plumbers, and to have more 'straight' professional appreciation."

This is viewed as an important credential, as the solutions they offer must be acknowledged as practical;

"We're coming from the 'sandals and candles', and everyone knows we're green, (we need) to prove that we can actually do something that isn't weird, and is acceptable, and every ordinary household could do it."

The AECB award scheme (see 4.4.3) is part of this process of changing industry perceptions. Fresh Water was concerned that the scheme may rebound. They are already well known in 'Green' circles, but they were adamant professional acceptance was more valuable. The ethical investment advisors, Enviro Loot also stressed that one business aim was to influence other businesses;

"Part of our agenda is to make ethical investment part of the mainstream. The more we succeed in that, the more we are going to make ourselves redundant."

Allied to this is a commonly held belief that more environmental improvements would accrue from many people making small changes in their consumption patterns rather than a few taking extreme measures. Changing behaviour is also an objective of Greencar Rescue;

"I'd rather a million people moved greener, and they moved in a way that they were able to without feeling their whole life had been shaken up."

The motivation of this company was reflected in the style of encouraging other people to making positive lifestyle changes out of choice as opposed to guilt;

"I'd rather that I wasn't saying 'Now, you're going to do this, because it's good for the environment'. I want them to see people who are doing it to a certain extent, and follow, and perhaps go further. That's the feel I want to get through, this is something we can do without feeling guilt, and shame and blame."

It was a commonly held view that incremental change through behavioural and technological shifts by many people was the most practical way to deliver environmental gains. It can also be concluded that in this group of enterprises the ability to influence conventional, non-green industries may be hindered by 'green' awards, while professional credibility is of greater commercial importance. This case of 'setting an example' ethos was not identified in the existing literature.

The effects of public concern about perceived environmental threats are also evident in some businesses, particularly the plastics industry. Solar Splash observed that there is considerable public antipathy to PVC in Germany because of fears that extruding and processing Polyvinyl Chloride (PVC) can have serious adverse side effects on health. Polypropylene (PP) is more commonly used and there is a great market for the material. The UK market may eventually shift away from PVC, although it is unlikely to be banned. Solar Splash emphasised the technical advantages of PP such as clean production conditions, new impact resistant and extreme temperature applications, ensured through stronger and more durable polymers, has gained them new markets in the micro-chip industry.

The interviews revealed significant issues affecting many businesses. These have been classified into three main areas, commencing with the effects of non-environmentally driven government intervention, changes in markets and unpredictability, and finally the effects of non-environmental industrial standards.

4.2.3 Government Intervention.

First, the effects on these enterprises of government intervention are discussed. These are a combination of the effects of regulation, privatisation and taxation policies. The industry most affected by legislation was the financial services. Enviro Loot observed that the entire financial services industry had moved from being virtually unregulated to being tightly controlled in a short period of time.

The central piece of legislation, the Financial Services Act (FSA) was triggered in response to inappropriate investment schemes and personal pensions. He commented;

"To a certain extent this was actually institutionalised. One of the things about the pensions mis-selling scandal is that this was actually supported by the Government."

The view was expressed that the sale of personal pensions was ideologically driven coupled with the rise in consumer optimism. Consumer safe guards were frequently ignored in the haste for the vendors to make more money from an enormously profitable market and a buoyant economy. The resulting public disquiet about how the financial services industry operated lead to the FSA. The interviewee suspected that it was also based on uninformed press comment;

"The Financial Services Act, in my opinion, was largely formulated through outrage in the leader column in the Daily Mail."

The agenda appears to have been set by those who were largely ignorant of financial services, and resulted in the draconian legislation. Enviro Loot took the view that although the FSA was flawed, it provided some protection for both consumers and consultants. Other changes involve the amalgamation of the regulatory bodies that govern the industry.

The second significant government intervention was the indirect effects of privatisation, particularly British Telecommunications (BT) and British Rail (BR). EcoBatts were initially unaffected, but lost their most profitable contracts, which had taken five years to establish.

This was largely because the newly privatised company delegated responsibility to staff for buying their own equipment. Many were reluctant to invest in high quality, expensive rechargeable battery powered torches. Post-privatisation contracts with BR were a similar disaster. It had taken the company seven years to negotiate the first order because of the long product testing process demanded by BR. Following privatisation, they no longer dealt with a central product procurement centre, which was replaced with some 28 franchisees. They have had to forge new contractual relationships among the new franchises entailing separate technical and commercial approval, which has taken three years to resurrect sales. Similarly, trade exhibitions also suffered because of the uncertainty in the rail industry.

The third aspect of government policy concerns that of Value Added Tax (VAT). The firms involved in promoting the benefits of solar energy (Solar Tech, Solar Splash and EcoChill) commented that there are conflicting signals from the government about fuel use. The political climate now appears to be more favourably disposed towards renewable energy technology, but VAT is levied on fuel regardless of its environmental impact. The privatisation of the UK energy industry has also caused fuel prices to fall, so there is no incentive to reduce consumption or switch to non-carbon sources. The lack of financial rewards, such as reduction or removal of VAT from 'clean' energy sources, has limited investment in solar technologies in the UK and was a recurring theme. It was suggested that the government could exempt renewable resources from VAT, a policy adopted by the Dutch Government¹.

4.2.4 Industry-Wide Changes.

The second major area concerns the general changes in markets experienced by the firms. Green Stick, the labelling company, commented that the industry is changing radically. The self-adhesive labelling industry is relatively new, and has only existed for around for 35-40 years. It has grown throughout this period, but remains a niche area, accounting for 3% of the overall printing industry.

¹ Since the interviews were conducted, the Climate Change Levy has become policy, due to come into effect from April 2001 (DETR, 2000) and favours renewable energy sources.

Increased competition may force the industry to change from many medium sized companies to a mixture of large organisations and niche firms;

"It will go back to service orientated companies and manufacturers"

The interviewee thought that most labelling would be by large firms, with specialist services provided by smaller businesses. For many small and medium sized firms, including his own, this presents a quandary of which strategy to pursue. Similar uncertainty was experienced by Solar Tech, who complained that the market for solar technology had been volatile for the past twenty years, and was dominated by organisations dedicated to promoting, rather than installing the technology.

In contrast to the UK market for renewable energy products, many firms observed increasing demand for their goods and services while simultaneously experiencing greater competition, largely from mainstream businesses. GreenAcres Building Society and Enviro Loot considered themselves to be under pressure from market entrants offering similar services. This has not yet become an issue as markets are small but expanding.

According to Enviro Loot;

"People who actually want to do ethical investment are such a small proportion of the market. It's less than 1% of the stock market."

Linked to this theme is the risk that larger firms will enter and dominate the market, or launch hostile take-overs. This was viewed as a potential problem for GreenAcres building society and Eco Word publishers. For the former, take over by another Building Society or Bank would lead to a minimal dividend for shareholders. This is an unlikely event, since it would require the members voting in favour of a deal. Most are committed to 'green' ideals and would be very wary of any changes of ownership. The Society does not have the capital base or resources to provide a full banking service, but are essentially a saving and loan institution. Apparently that has not deterred the unwelcome attention of speculative 'carpet baggers'. The interviewee thought that the only circumstances that might be favourable were if they operated as a specialist division within a parent company, although this may endanger their independence.

The threat of market entrants remains a concern for Solar Tech, but the general experience of the solar water heating niche has been characterised by brief appearances by competitors followed by rapid withdrawal. Solar Tech recalled that two large energy suppliers and metals interests attempted to break into the market. One withdrew because of inadequate markets for producing and installing equipment. The other tried to use an inappropriate material, which resulted in solar panel failure.

Just one firm, Solar Splash, felt they were adversely affected by the strength of Sterling. This has been attacked by some industries for reducing competitiveness abroad and making imports relatively cheap. The company noted that that this made technically inferior products more attractive. They did not feel threatened by such goods, but the profitability of some exports markets has declined although sales remain buoyant. In this survey, few firms exported, so it is unsurprising that the strength of Sterling was largely a non-issue.

4.2.5 The Effects of Non-Environmental Industrial Standards.

The final part of the section details the effects of non-environmental industrial standards. A dominant theme was the cost to smaller firms of registration for standards, including the mandatory CE mark for products and British Standards Institute approval. Where appropriate, it was generally felt that self-certification was the preferred option because of costs.

This was an issue for both Solar Tech and EcoBatts, who agreed that the costs of registration for ISO9000 and associated annual site visits to ensure compliance were excessive costs to firms with low turnover. Another aspect is the imposition of standards through supply networks. This was commented on by many of the firms, both product and service based. It was also predicted that ISO 14001 (Environmental Management standard) will follow, and is of obvious benefit to Green Info, the video training company.

This development was noted by Green Stick, who have already registered to ISO9000, and both Investors in People (IIP) and ISO 14001 are on their agenda;

“(ISO14001) is something we will be looking at. I know that the major multiples are asking those kind of questions. I think within the next few years, whilst we haven't identified it as a business need, we are looking at it. We have got ISO9002, and we are looking at the Investors in People, and the environmental standard will follow. And the end users are looking for it. It probably shows there is best practice within a company, if the environmental standard is there.”

This battery of certificates should give them a competitive advantage, while the TQM standard (ISO 9000) is virtually mandatory for winning contracts. He observed that firms had to adopt the standard in order to remain on lists of approved suppliers;

“If you haven't got it (ISO9000) now, you don't even start talking to them.”

This experience contrasts with that of EcoBatts who supply torches to the Ministry of Defence (MoD). The interviewee observed that while the MoD stipulated compliance with ISO 9000 for all contracts, they are inconsistent, and in practice purchase purely on price. This appears to be an exception, and for the majority of all firms, standards are viewed as an important feature of the business horizon. An attitude of 'compliance plus', or the drive to exceed minimum standards is evident in many of the firms studied. Excellence in business practices is seen as commensurate with 'greenness'. This perspective applies to all legislation, and will be discussed in the section on environmental regulation and standards. It is in contrast to the prevailing view that all SMEs are environmentally regressive.

This concludes the analysis of the general business environment. The next section addresses the strategies and options for growth adopted by the enterprises.

4.3. Strategies for Growth.

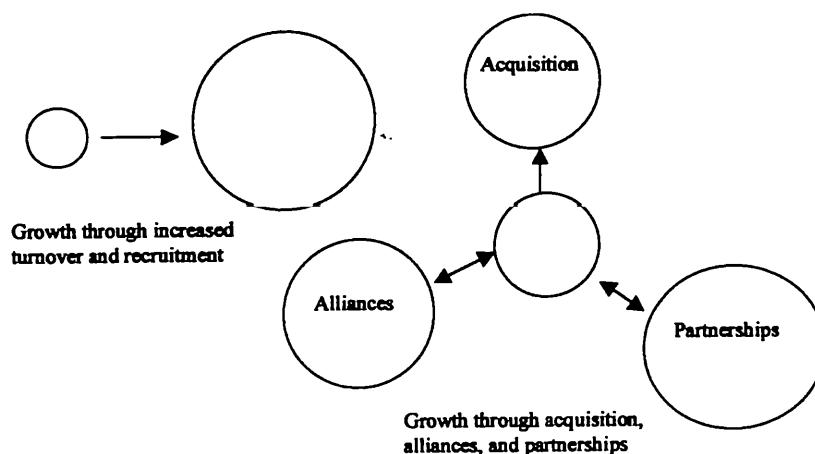
This section analyses growth in two ways. First, the process of growth itself, and second, the implications for management and the evolution of products and services. The interviews revealed that growth can be achieved by several processes.

These include increasing turnover and recruiting more staff, acquiring other businesses, or forming partnerships and alliances with other enterprises. All the firms interviewed expressed the aim of expanding with varying degrees of enthusiasm. The publisher, Eco Word, regarded themselves as a typical, expanding small business;

"Growth is exciting, but growth is also hugely problematic."

The options are summarised in Figure 4.2.

Figure 4.2. Strategies for Growth.



Expansion has implications for recruitment, management strategies, and developing technology options and services. The interviews revealed that most growth within organisations is anticipated by productivity gains from existing staff, or recruiting new employees. Since most expected to increase employment, this shows how 'green' goods also contribute to employment creation. Some firms experienced problems locating suitable staff. The Enviro Shop suspected this was because of a combination of factors. The interviewee complained that he has been unable to find qualified car mechanics;

"We are suffering from what went on in the eighties when nobody trained."

This relates to his commitment to sustainable business practices expressed through his belief in maintaining a strong local economy through his insistence on employing local people;

"I won't have anybody from too far away. I don't think it's sustainable with the commuting. I think also if they work in the environment that the business is drawing its customer from, then they're likely to look after somebody's car better if they're likely to meet him in the pub tonight when they go out for a drink...(There is) A bit more responsibility towards the customer from the staff, and the customer to the staff. They are not so remote from each other."

It also raises some important policy issues for growth oriented businesses. Dodgson and Rothwell (1989) commented on the need for more educational effort to produce highly skilled manpower and overcome this crucial weakness in the UK workforce. More positively, EcoChill managed to recruit acknowledged specialists in renewable energy to reinforce the team and increase their reputation. These comments reveal firms have a good understanding of environmental issues working through to business practices. Some of these firms may be even more advanced in this respect than larger organisations.

The acquisition of other firms may present problems that demand reorganisation of the enterprise. The interviewee from Green Stick observed that growth may force them to become a specialist division within a group of companies. They have observed that this approach has been successful in other companies. They are recognised as experts in dealing in short print runs in specific industries, and;

"If you're very good at food labelling, you understand food labelling, and you understand the idiosyncrasies...So you're up and running every time you get a job."

The second strategy for growth is the acquisition of other existing businesses. This option is being explored by several firms, including Solar Splash and the video production company, Green Info. Both aim to complement their core activities and absorb other forms of communications businesses, including electronic media and printing.

For both firms, it is a means of increasing turnover, acquiring the skills, equipment and customer base of target firms. The third option for businesses includes forming strategic alliances, partnerships or networking with other firms. This is illustrated by Solar Splash, who formed an alliance with an Austrian firm that possessed more technical resources, and another with a Dutch firm that specialises in large diameter, heat welded pipes. The strategy is to increase their profile abroad, enable them to compete with market leaders and protect existing markets. The water conservation partnership Fresh Water, were exploring the potential of a partnership with a plumbing firm to put their ideas into production and possibly extend into retailing;

"They would be the front end, we would come in as the consultants...that would be a way of gearing things up. Particularly in the water efficiency direction."

Informal networks or sub-contracting are particularly attractive growth strategies for services. EcoChill overcame the problem of producing their refrigerators by contracting the work to a specialist manufacturer. Both architects, GreenBuild and EcoBuild, have mimicked large organisations by establishing a network of 'Associates'. This enables collaboration on projects with like-minded professionals on a flexible basis, without the need for rigid management structures or investment in overheads, such as dedicated office space. GreenBuild explained that the agreement was reciprocal;

"Although they (clients) see me, I work very closely with, a number of other professionals. So, for example, there are two structural engineers who I have a good rapport with... A service engineer, a heating engineer,...a green electrician...a landscape architect,...two planning consultants... And they likewise phone me up, and lean on me."

This partnership relationship also has the effect of avoiding competition within 'green' architect practices.

Another way of overcoming the problem of limited resources and management time within a small firm is to sub-contract excess work on a flexible basis. This is how Greencar Rescue and Fresh Water overcome the limitations of a small organisation, a strategy determined by cost effectiveness.

For Greencar Rescue, a moderate rate of expansion would enable them to provide their own services without the need for extensive use of sub-contractors as each function became cost effective. This firm has imitated another motoring organisation and contracted out the operations and agent network. In both cases all except core activities are sub-contracted in this variant of flexible specialisation.

4.3.1 Management and Strategic Development.

The process and management of growth have proved to be highly problematic for many firms. Some key decisions have to be taken regarding strategic management approaches, the structure of the enterprise, marketing and recruitment and training policies, and will be dealt with in turn.

Strategic management decisions may affect the future directions of an enterprise. The interviews with EcoBatts, Fresh Water and Green Stick revealed concern about the nature of their businesses. This dilemma was exemplified by EcoBatts. The interviewee was concerned that they were originally product development oriented, but the future direction for the company is less certain;

“One of the problems with a company like us, it is easy to really lose your focus, and forget what you are. Are you research and development, are you manufacturing, are you distributor? Where do you put the balance between marketing your products and developing them?”

All the companies agreed that product and service diversification is strongly associated with growth. It offers greater flexibility, differentiation and access to new markets. For example, Fresh Water, augment their core expertise in reed beds by importing a water efficient toilet from Sweden, illustrated in Figure 4.3. They are also developing water-free toilets and an electrical rainwater management system. They were concerned that such imported goods may be incompatible with the UK water supply system.

Figure 4.3. Water Efficient Bathroom Suite.



Their strategy for growth fuses their personal, business and ecological directions;

"We could quite easily be doing specialist things in remote Islands, and doing super-green systems for five people a year, and live on that. But we're quite excited at moving towards something that's more applicable to every house."

EcoChill share the same objectives as Fresh Water, which is also aimed at increasing markets and access to their expertise. The business has produced a five year strategy designed to blend personal goals within an awareness of the current and future political climate for renewable energy. This includes investing in R&D, product development and new and appropriate technological ideas within their business capabilities.

The process of expanding a business has implications for management structures. In some cases, such as GreenStick, the owners introduced a very flat structure with short lines of communication that could survive further development. The partners always believed in 'leading from the front', but recognised the need for devolution;

"We had to put the structure in place to spread the responsibility right through the organisation, so the organisation could move forward, as opposed to the director owners."

Growth may demand restructuring of an enterprise. In some firms, including GreenAcres and Enviro Loot, it is possible this process may lead to a regionalised, highly devolved organisation. This would enable discussions of strategy, and encourage local support, motivation and business control.

It is evident that formal business structures enable the management of growth. This includes business strategies such as recognition of Investors In People (IIP), which implies that an organisation is committed to staff development and training. Several firms thought that it was critical for future expansion. In the case of GreenStick, the interviewee was originally responsible for production and administration, while his partner was responsible for sales and commercial aspects. This meant they had to be 'jack of all trades, masters of none'. A more formal structure was required to facilitate growth. This led them to pursue the IIP;

"One of the main aims for this year is to achieve the 'Investors in People' accreditation. It's to rubber stamp that the last three years' activities have been worth while."

The breakdown service, Greencar Rescue operated on a similar basis. Their own systems manage to combine informality with quality. When the organisation started, procedures included staff names because of a preference to maintain this personal touch, but system development will require depersonalisation. As with Green Stick, the organisation expects IIP will also eventually become a growth related issue.

The management of personnel and Information Technology (IT) is vital for company growth. Several enterprises are highly information intensive. The 'Y2K', or 'millennium bug' problem caused some concerns, but Greencar Rescue is acutely aware of its value. Their new computer system is not only 'Millennium proof', but they are also unusual for a company of this size to have a specially designed database. This company also benefits from its ability to emulate larger firms through exploiting the advantages of IT.

Another key management resolution is to dedicate greater resources to marketing in the UK and abroad to increase turnover. This has been the choice of strategy for EcoBatts, who were aiming to increase productivity within the present manufacturing base. The additional revenue will eventually generate surpluses that will promote them into a more rapid growth pattern that will influence their advertising strategy. Two service based firms, GreenAcres and GreenBuild, both predicted greater activity in latent but expanding markets that had yet to find natural limits. One interviewee commented;

"We are still probably not known to everybody who would call themselves 'green'. This is surprising, but that is the case."

Developing export markets was viewed as important for some businesses. Both EcoChill and Solar Splash found they need to establish and manage networks abroad. The former is developing a network of agents in targeted markets, including South America, Africa and India. The other firm has established links with companies in Austria and the Netherlands. Both firms have access to increased technical resources that will allow them to compete with market leaders in Europe. This will entail raising the profile of the firms through Public Relations (PR) exercises and trade exhibitions. The GreenAcres Building Society representative thought that they needed to channel more energy to informing their members and prospective clients about their activities. This is likely to be achieved through sub-contracting their PR requirements.

Several firms experienced difficulties with specific organisational problems, including recruitment and skill shortages. EcoBatts experienced major problems when they recruited a professional marketing manager and decided to expand the marketing team.

This task was previously the responsibility of the MD. The marketing team evidently evaded their responsibilities by foisting this role onto the distributors, who failed to promote the products. The MD consequently realised the importance of supporting their distribution network and had to regain lost sales.

Several service firms, notably Green Info, Eco Word and Greencar Rescue were acutely aware of the importance of providing information and training their own staff, particularly about environmental issues. This was particularly acute for Green Info, the video training specialists who deal in communicating 'best practice' to other businesses. Greencar Rescue are developing processes to link their business practices and objectives to their training programmes with the goal of increased productivity. Besides allowing staff time to attend college, they also hold two training events each week to reinforce knowledge of company policy. This is partly driven by demands for information from the membership, thought to be more interactive than members of other organisations. They also receive requests for information about both Government transport policy and their own performance. They need a flexible, well-informed and dedicated staff, capable of dealing with a wide range of tasks;

"Because we're relatively small, we can't have people who only do one thing. And they find work here much more interesting because it is so varied."

This analysis of the strategic implications of growth concurs with other research into the growth of SMEs, such as Barkham et al. (1996), Gray (1995) and Storey (1994). All noted that growth can be a very difficult, but vital transition for business founders, who have to learn to delegate responsibility to overcome some serious barriers to growth.

4.3.2 Technology and Service Evolution.

The final part of the section on the growth of firms details the strategies for developing products and services, crucial to the process of expansion. This complements the later analysis on the innovation strategies adopted that produced the initial goods and services. Two approaches are evident from these interviews. The first is developing new products that augment their current range. The second is further development of services for differentiation from competitors.

4.3.2.a Product Diversification.

Several firms, notably Solar Tech, Fresh Water and Enviro Shop, have explored the combining existing technologies with other types of products that complement the service delivered. This is how Solar Tech intends to expand. The intention is to develop novel environmental technology projects, such as a device for ventilating houses with filtered air to remove the problem of condensation and pollen. The water conservation partnership, Fresh Water, and the retail outlet, Enviro Shop have similarly diversified their interests in response to growing demand for environmentally preferable products. Both have extended their expertise in solar energy, water conservation systems and petro-chemical free, natural paints and cleaning materials. Enviro Shop is faced by development restrictions imposed by their rural location. The preferred route for diversification is the development of rainwater collection technology. If this proves to a flourishing manufacturing venture, they will need to locate suitable premises, and the current site will revert to a showroom. This raises the added dilemma of creating a manufacturing base in a rural environment. Conversely, Solar Splash recognised the technical constraints of their solar panels, which in their opinion can undergo limited refinement and has few alternative applications. They are unusual in this selection of firms as the solar panel division constitute a minor part of the overall business. They identified the need to acquire skills in other businesses to augment their core expertise in manufacturing pipes and moulded fittings. Increasing their product range includes developing their fabrication capacity for the manufacture of chemical storage tanks and novel ways of joining plastic pipes and fittings. The firm believed that a comprehensive package of products and services would enable them to compete with larger UK businesses because of customer demand for centralised supplies.

4.3.2.b Service Evolution.

The second option is the development of complementary services. Several manufacturing firms reported that the service element of the business was becoming a more important feature. For example, GreenStick and Solar Splash felt that their commitment to service enabled them to differentiate from their competitors in an increasingly homogenous market. It also added value and was perceived as an aspect of quality.

Green Stick remarked on the standard of their service provision;

"We're quite pleased that it is noted by customers, and customers do compliment us. In fact one of our customer services guys actually got a Christmas present from one of our customers, which is a nice role reversal! That's the kind of level of commitment we put into our customers."

In the same way a basic product design can become a platform for other designs and enterprises can extend their service provision to match their competitors. Greencar Rescue has added to their initial, limited range of services, and now offers a cheap basic service with additional features to increase their audience. This strategy is based on risk analysis and allies them more closely with motor insurance than breakdown recovery. Greencar Rescue are able offer this facility because their organisational style of flexible specialisation gives them an advantage over established organisations as they can adapt to changing market conditions more rapidly at lower cost.

Product guarantees can also be viewed as service dimensions of products. For EcoChill, it is a contractual obligation for supplying goods to two major NGOs, and they predicted this will become more common in the future. Greencar Rescue based its entire operation on a replica of a pre-existing, successful organisation. The provision of a strong service in support of products can also present logistical difficulties for small firms. Both Fresh Water and EcoChill commented that it was economically unfeasible to service distant clients. For this reason, the latter company now concentrates on large scale, non-domestic applications of their renewable energy systems. They operate on low margins and high overheads;

"If we do a wind and solar powered system for a house in Cornwall, which might cost £5,000 or £10,000, then we cannot really afford to give that the full after service that it would require."

The bureaucracy and after sales support demanded by small and large contracts are often comparable and would render such business uneconomic.

Another route to service provision is through leasing. EcoBatts observed that leasing arrangements of their equipment would be a very difficult proposition, but recognised it as an increasingly valuable market.

The equipment hire industry has become more complex because of changes in legislation that require all electrical or hazardous mechanical equipment to be completely rechecked following use. This problem could be overcome by selling their products directly to the hire industry.

4.3.3. Summary.

The review of strategies for growth reveals the intention of how the firms intend to expand through a combination of business development with product and service diversification. This may have significant impacts on the organisational structure of the firms. Networks of 'Associates' and sub-contracting are attractive options for 'green' businesses to avoid bureaucracy and management hierarchies. Product and service diversification offers the advantages of new markets and differentiation from competitors. Firms are also responding to the challenge of providing additional services, such as guarantees to complement their products.

4.4. Environmental Issues.

This section of the chapter concerns attitudes to environmental issues prevalent in the firms surveyed, followed by an analysis of how they reacted to legislation and voluntary schemes.

4.4.1 Attitudes to Environmental Issues.

What is striking about many of the firms in this study is the posture of 'compliance plus' from Roome's (1994) classification of environmental postures (see Chapter 2). The following quotes in Figure 4.4 serve to illustrate attitudes regarding environmental issues in general.

Figure 4.4. Attitudes to Environmental Issues.

"We have got ISO9002, and we are looking at the Investors in People, and the environmental standard will follow. And the end users are looking for it. It probably shows there is best practice within a company, if the environmental standard is there."

"It is partly an ego thing. You like the stuff coming out the end of a sewage system to look like drinking water. It may only need to meet a weaker standard, but we tend to try to put it to soil rather than into a stream. Generally we'll try to specify more than is needed. There's issues with price, but generally the people coming to us want to do the best thing, and we tend to talk people down from something more elaborate to something more economic."

"Ideally we want to not just comply, but go beyond compliance...I think we should be an example. If we are delivering information that advises them on good practice, and we are not carrying out that good practice ourselves, that it ethically wrong."

These attitudes reinforce the picture that being environmentally active is strongly associated with a desire to be seen as a well-managed, efficient, high quality operation. What also emerges is the general intention by the firms studied to be perceived as adopting 'best practice', or a position synonymous with at least 'compliance plus'. This attitude also relates to Brezet's (1997) four stage model of environmental innovation, introduced in Chapter 2. A position of excellence regarding legislation can be viewed as consistent with firms that are at least at the second, product or service redesign phase of development.

4.4.2 Environmental Regulations.

The second part explores how these attitudes are reflected in reactions to mandatory legislation and voluntary initiatives, summarised in Table 4.3.

Table 4.3. Summary of Environmental Issues.

Mandatory	Voluntary
Waste Regulations	Waste (packaging); includes reuse, recycling and minimisation strategies
Minimum Energy Efficiency standards	Energy efficiency (good business practice)
Other regulations; Discharge Consents, Building Regulations, ban on CFCs, Health and Safety in the workplace, COSHH	Industrial Standards (e.g. ISO 14001) Information; Awards, Corporate reporting, Environmental policies and verification.

The manufacturing firms were those most affected by environmental regulations. The most commonly cited were waste regulations, Health and Safety issues in the workplace and energy efficiency standards. Other environmental legislation has minimal impact on the manufacturing firms in this survey as they have limited exposure to chemicals or proscribed processes. The effects of waste regulations, particularly those relating to packaging, were a problem because the regulations are relatively new and still changing. They have affected several firms, and it is the confusion arising from uncertainty that prompted Green Stick to engage in their product redesign initiative. Changes in the legislation mean that many such firms will become liable for the disposal costs of their waste packaging. Their approach to resolving the problem is summarised in Figure 4.5.

Figure 4.5. Packaging and Waste Directive. An Industry Response.

GreenStick originally understood that because their turnover was below £5m per year, and until recently they produced less than 50 tons of waste per year, they were exempt from the new packaging and waste directive. Confusion arose because the directive appeared to apply to firms that exceeded either a minimum turnover or quantity of packaging waste threshold. The position is further complicated as the self-adhesive labelling industry was originally exempt from the directive, as labels were considered to be a separate, decorative item, distinct from the container, or packaging. This decision has been reversed. Consequently Green Stick was surprised to find they were liable for the costs of disposing their waste packaging. Some enterprising trade schemes were created to help businesses deal with their packaging waste. These schemes sold certificates that confirmed the company was compliant with the directive. The company that issued the certificate inspected, monitored and removed their waste, and charged them for this service.

(Figure 4.5 continued)

Their reaction to the directive was;

"It came in two stages. First there was the panic, 'how do we join this?' Then there was a realisation that labels weren't part and parcel of the process, so we were all right. And then we were told it was going to happen, but we weren't involved because we were under £5 million. The jury's still out on that one, I believe."

This confusion was the stimulus for reducing their waste liability that finally found expression in a product redesign strategy. They hope to gain both environmentally and financially;

"We have completed an exercise where we've tried to minimise waste on a particular job which will have benefits because it will come back into the business, and also benefit the environment."

The benefits derived from this process is not exclusively due to environmental pressures, but also subject to strong commercial pressures from their clients;

"It tends to be end user driven, because everyone's looking for a better price at the end of the day."

Their actions reinforce the message that waste minimisation makes commercial practice;

"Everybody benefits at the end of the day. Environment benefits, the company benefits."

GreenAcres building society, GreenBuild and EcoBuild all identified compliance with energy efficiency standards as their most important concern in the service they provide to clients. The architects routinely exceeded the minimum standards of insulation and energy consumption demanded by current building construction regulations. This is largely due to their philosophy, encapsulated by this comment;

"Environmentally, there is clearly a big justification for putting extra insulation in, because you're putting up a building that is going to be less of a demand on the world for the duration of its life."

In marked contrast to the commonly held opinion of how SMEs view legislation, both Fresh Water and EcoChill are engaged in the process of establishing appropriate industry standards with regulatory authorities.

In common with the packaging regulations, there is considerable latitude concerning water conservation technologies and the siting of renewable energy facilities. For example, at present there is no standard for the water treatment techniques pioneered by Fresh Water;

"We're doing all sorts of wild and wacky things that don't meet any British Standard....For reed beds, there was no standard. What you have to do is meet the quality at the end of the pipe."

This approach has both advantages and disadvantages, as the interviewee observed;

"It's also nerve wracking in that you can't say 'we followed this British Standard, therefore we're in the clear' if anyone tries to sue us. But at the same time, it's nice and fuzzy, because we can say 'this is experimental', and if it doesn't work, we can come back and fix it, and we can do this, and we can negotiate."

This position is echoed by EcoChill, who also design and install wind farms. They engage with relevant bodies to design acceptable systems that will cause minimum disruption to natural habitats. They recognised that other wind energy developers would need environmental assessments to gain approval for the siting of wind farms. This aspect has developed into an additional advisory service based on studies they have conducted to determine appropriate standards.

For most of the service providers, there is little regulation applicable beyond Health and Safety as they are not manufacturing premises. Several businesses have their offices located within their own homes. Regarding the governance of services generally, little regulation has a direct environmental aspect. For example Enviro Loot noted;

"The Financial Services Act has no environmental provision of any description."

Services generally are not subjected to a barrage of environmental legislation, but voluntary industry initiatives may be more relevant.

4.4.3 Voluntary Schemes.

This section addresses five types of voluntary initiatives that were mentioned in interviews. These ranged from waste minimisation schemes, energy efficiency projects, industrial standards, environmental reporting and finally award schemes.

Several firms reuse, recycle or have reduced their waste packaging output, primarily for economic reasons, regardless of the legal imperative as described in the previous section. Energy efficiency practice in the workplace is similarly regarded as good business practice, and often associated with their business philosophy.

There is a more ambivalent response to the issue of industrial standards. Green Stick and Green Info suggested that ISO 14001 is likely to become an important factor in supply chain relationships, and closely follows from TQM (ISO 9000). Two other respondents disagreed, claiming that the cost of registering with formal environmental systems was prohibitive;

"I think we're like a lot of other small businesses. The costs of compliance would be very, very high."

Company environmental reporting or access to such information is significant for several firms. Two firms publish, or intend to produce an environmental report. Of these, Greencar Rescue aims to produce an annual report that reflects their environmental, social and financial performance. Another company has an environmental policy that guides their own working practices. The financial consultants, Enviro Loot, use the services of an external organisation to measure the environmental sensitivity of investments, which enables them to avoid unethical and environmentally suspect funds;

"You get a lot of cases where somebody has been sold something which says 'incredibly green environmentally sensitive fund' which only invests in small portable nuclear powered child abuse."

Finally, awards may be useful for promoting 'green' issues with industry and consumers, but several respondents were sceptical of their value.

EcoBatts commented on the fact that although they were selected for interview on the basis of receiving a green product design award which is featured in all the publicity literature, the marketing team were adamant that;

"We cannot cite a single case where we can prove that it made a difference."

Fresh Water was dubious of the value of 'Green' awards. They suspected that such schemes could marginalise them;

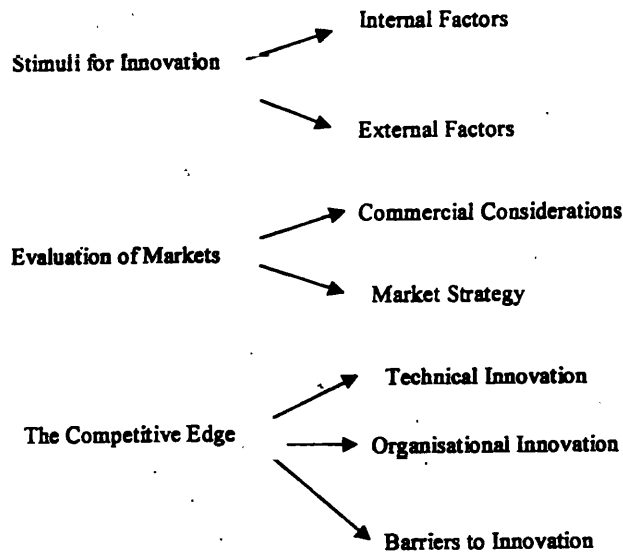
"I think it's a great idea for certain companies, but we're almost branded with it, fighting to be not seen as just 'wild, wacky green', but to actually have stuff that will work in an ordinary house."

Being 'green' also implies the pursuit of 'best practice' in these firms. They aim to exceed minimum regulatory requirements where applicable, even in cases where regulation is evolving. Services are virtually unaffected by any kinds of environmental regulation or voluntary codes of practice. The cost of compliance with standards produced contrasting responses. Some enterprises regard it as inevitable, driven by supplier demands. Others are more circumspect, noting that the cost of registration is disproportionately high for small businesses. Of particular note are the often restated values of excellence in environmental terms being synonymous with excellence in business terms.

4.5. Innovation.

This is the final section of this chapter and examines the drivers for innovation, evaluation of markets and the competitive advantages of the innovations. Innovation in this context includes technical and organisational aspects. The structure of this section is illustrated in Figure 4.6.

Figure 4.6 Aspects of Innovation.



The first part analyses the drivers for innovation, and the transcripts revealed a mixture of internal or external pressures. Internal decisions are those relating to ideas emanating from within the business, or led to the creation of a business. External factors relate to market opportunities or potential competition.

4.5.1 Stimuli for Innovation: Internal Factors.

Nine of the fourteen businesses claimed the enterprise was based on the decision of a founder to convert a 'green' ethos or product idea into a viable enterprise. This approach is illustrated by the partner in the water conservation enterprise, Fresh Water;

"I feel lucky I can earn a living from doing what I'm excited about, and I'd be doing anyway as a hobby."

The same motive was apparent behind the Enviro Shop;;

"Commercialism didn't come into it. It doesn't come greatly into my business at all. Although it doesn't seem to have done too badly without it! It's more what I think is right."

Two firms, Solar Tech and Solar Splash, took more formal business decisions to diversify their existing product range, or acquire complementary technology. The commercial considerations underlying the innovations were the desire to increase turnover, extend the range of expertise or reduce operating costs. The drive to reduce operating costs involved a novel approach to waste minimisation through product redesign, and will be discussed more fully later.

4.5.2 Stimuli for Innovation: External Factors.

Five enterprises identified increasing demand for 'green' goods and services, or perceived a threat from potential competitors, and in one case pressure from packaging regulations. New market opportunities were identified by several firms, typified by Green Info. The business was built on the production of industrial training materials, and they noticed;

"There was a lack of tools or training materials that presented all the environmental issues, in terms of training the workforce. There is a lot of confusion about the global issues."

They compiled a package that described the major environmental impacts and pressures on business. Their expertise allowed them to customise videos to the needs and circumstances of individual clients.

4.5.3. Evaluation of Markets or Products: Commercial Considerations.

The second section on innovation details the commercial importance of the 'green' product or service, and the effects on marketing strategy. The commercial significance of 'green' goods and services to the firms is shown in Table 4.4.

Table 4.4. The Commercial Significance of 'Green' Products and Services.

Contribution of 'Green' Product or Service	Number
Total	6
Significant (>30% turnover)	3
Minor (<30% turnover)	2
Not Known	3

Six of the firms relied exclusively on the 'green' service for their turnover. These enterprises were established to market the 'green' products. This had implications for their awareness of markets and marketing strategies. The transcripts reveal that few firms undertook extensive market research prior to commercial production. Most based their business decisions on anecdotal evidence supported by their environmental convictions or professional reputations. This is particularly the case for services. The representative from GreenAcres building society claimed;

"It's our belief that there is a substantial community of people who are interested in 'interesting' buildings, and also increasingly aware of environmental problems and what can be done to solve them, and therefore willing to contemplate things that are new and unusual."

This belief in the potential markets for services underpins other enterprises. In contrast, just two firms, EcoBatts and Greencar Rescue conducted thorough market research exercises intended to demonstrate the viability of the business proposition. Regardless of the projections obtained from market research that suggested an entirely new entrant into the vehicle rescue business would fail, Greencar Rescue took that entrepreneurial risk;

"Despite the fact it seemed like a hopeless case in the beginning, we went ahead, because the costings looked that way. We had to convince enough people in the first few days, with enough goodwill, to pay to join. And they did."

It seems from these interviews that the originators of these enterprises were willing to take risky entrepreneurial decisions based on slight, or contradictory marketing information, but the resulting enterprises have survived. This suggests that marketing is of limited value for innovative products that consumers are unable to evaluate.

4.5.4. Market Strategy.

Moving from assessing how the firms investigated the market potential for their ideas, the next section looks more closely at their markets. Analysis reveals that they adopt similar strategies to any other SME. They tend to avoid direct competition. The firms are well positioned as pioneers to exploit their present niche markets, but judge they offer considerable future growth potential. These enterprises have an advantage as they often compete against what they consider technically inferior products, and price is not a major competitive issue. In practice, they are rarely in direct opposition to identical products. The perception of quality is embellished by the view of EcoChill;

"Ours is the Rolls Royce. It is more expensive, but it's the biggest. It's got a strategic value in the sense that it's not appropriate for every single need, every single location, but it's appropriate really for the larger remote hill stations, strategically located, not necessarily the end of the line one."

Any competition tends to be from geographically distant businesses. This is partly a function of the underdeveloped nature of these markets, where co-operation is possible. For example, Fresh Water commented on the present market for reed beds;

"Our competitors are probably doing the same thing as us. There are enough jobs in Britain, and so few people doing this at the moment."

And;

"Only in a few counties you're going to have someone doing something alternative. A lot of the conventionals will put on a reed bed at the end...and water companies are using reed beds...Our main competitors are other people doing it, and we're all quite busy."

Enviro Loot also commented on the lack of competition;

"There are fifty million people in the country, and two hundred and fifty ethical investment advisers. We don't need to compete. The market place is quite large enough for us to co-operate."

Not only are potential markets large, but some firms are able to exploit their specialist knowledge of 'green' technology, and effectively create barriers to entry from competitors. This has benefited GreenAcres, who noted that other Building Societies have occasionally attempted to enter their markets, but rarely endure;

"What we've tended to find so far is that they either dip their toe in the market, and then they pull out. Perhaps there's no money to be made, or they've gone through their assessment and the risk is too high. Or they start hedging it round, so in some circumstances individuals find they can get the money, and in others they find they can't. Perhaps it's just a bit too much for them to take on board. So it tends to be very piecemeal."

This enables them to retain their pioneer status in developing niche markets. It has been seen that these firms also aim to influence current, largely non-green practices. This poses the risk that they may become redundant, but because markets are dynamic, and their influence is minimal at the moment, they can always remain ahead. GreenAcres characterised this position;

"You always run the risk that your reason for being there disappears. We will perhaps have to compete on price. People in the environmental community I've spoken to have expressed the view 'there will always be a role for you because other building societies will create a new paradigm'. They take some ideas on board, and create a new status quo somewhere else, beyond which we need to move, because it's a dynamic thing."

The businesses understand their niche markets and are capable of exploiting them, unlike non-specialist entrants. They also offer products or services that do not compete on price alone, and those competitive advantages will be discussed next.

4.5.5. The Competitive Edge.

The final part of the chapter investigates the technical, organisational advantages of the innovations, and briefly discusses one case where circumstances beyond the control of the company prevented an innovative product reaching the market.

4.5.5.a Technical Innovation.

Two technological strategies are apparent in this group of companies. The research reinforces the analysis of innovation by Gardiner and Rothwell (1989). These can be summarised as follows:

1. The innovation is a robust design, which allows design variants or a family of products based on the technology.
2. The innovation contributes to an existing array of products, and provides diversity.

EcoBatts rechargeable batteries is an example of the first type, while the solar water heating devices marketed by Solar Splash represent the second. These products tend to compete on non-price aspects. In the opinion of several interviewees, there are significant technological advantages offered by the 'green' products. These include reduced operating costs, durability, reliability and simplicity of use.

The technical advantages can be illustrated with reference to the design characteristics of the rechargeable battery.

Figure 4.7. Technical Advantages of the EcoBatts Recyclable Dry Cell Batteries.

Rechargeable batteries are cheap to operate and maintain constant voltage throughout discharge providing they are correctly charged and discharged. The idea behind this product was to provide battery users with built-in charger that appeared identical to a disposable battery. The rechargeable system offers several technical improvements over conventional batteries. The life span of a typical dry cell battery is dependent on a range of factors, including ambient temperature, mode of use, and duration of resting period. This rechargeable cell is a much more physically robust system. It cannot be short-circuited, is more powerful, has an indefinite shelf life and can be stored in a discharged state for long periods of time. It can be used with any mains voltage or car battery, and cannot be over charged. The batteries can also be repeatedly recharged without loss of performance, have very low internal resistance and dynamic impedance, and maintain a constant voltage output. Other batteries have poor internal resistance characteristics, such that when a load is applied, the voltage drops.

Fresh Water are an unusual firm in this respect, in that they do not promote one specific technology, but tailor solutions to the needs of their clients, making them more analogous to service providers. Their core competence is based on reed bed technology, they aim to offer water conservation solutions;

"We don't go in to sell a reed bed. And that's where we're different. People call us and say 'we want a reed bed', and we say 'we can't promise we'll be suggesting a reed bed,...but pay us to have a look', and we may suggest getting in a local chap to put in a septic tank, because that's your cheapest, most ecological solution."

The technical contribution made by the 'green' product, or problem solving strategy used by fresh Water also has implication for the organisation.

4.5.5.b Organisational Innovation.

What emerges from the interviews is that the services appreciate the 'green' technologies they promote, and this allows them to define alternatives to non-green services. This is strongly linked to close understanding of their client profile. A good example is GreenAcres, who are able to finance unconventional buildings that other Building Societies would reject. They are able to support listed buildings, and vernacular construction methods, such as cob or clay.

They have not necessarily invented new styles of delivering their services, but have imitated models of larger scale enterprises. Greencar Rescue justified copying successful organisations;

"Why reinvent all those wheels? That's enormous reinvention. Pick something that's 80% good off the shelf, and then learn once you know."

Organisational innovation of services is limited, since there are other business models that can be adapted. A combination of technical superiority and organisational skills has enabled the great majority of firms to exploit products and services. One firm adopted an unusual style of innovation management, but was unable to overcome an organisational problem and develop a 'green' product for mass markets. This is an example of an external barrier that prevented the introduction of a 'green' design, and is explored further in the following section.

4.5.6 Barriers to Innovation.

In one case, the enterprise failed to realise their product in the marketplace. Green Stick's design strategy has already been outlined, and was due to reaction to the packaging regulations. Their approach was a combination of technological and organisational strategies involving control of the supply network. This was an unusual approach for a small firm. They took the initiative to solve a problem presented by environmental legislation, and demonstrated the difficulties in introducing environmental motivations into complex supply networks. The key barrier for entry into mass market, fast moving consumer goods (FMCG) is the inability to realise economies of scale, and becomes a resource cost issue. The exercise for GreenStick was justifiable because it finally provided a detailed analysis of production costs, and demonstrated what environmental gains could be realised through novel means of communication and managing resources. The commercial reasons for the lack of progress are outlined in Figure 4.8.

Figure 4.8 Supply Chain Innovation in Packaging.

The project changed their style of managing their supply chain relationships through understanding the technical specifications demanded by the other firms. Their own products, the labels, constitute a minor part of the total package, but they decided to identify and control the environmental impacts of each stage of the manufacturing process. This required each partner in the supply chain to justify the cost of materials;

"Before we knew it, we had a forum of people. In simplistic terms, we just took a bottle. Or you could take any product, and we just put it on the table, and said, 'Right. Who makes that? Who is involved in the manufacture of this thing?' Let's get them all together, and talk about why we're doing what we're doing. Because we can't understand it. We're just part of the chain."

The process culminated in a fabric conditioner bottle;

"Initially we're looking for business benefits, but environmental benefits come out of it, because we find ourselves making it better. And making it better, it tends to be more efficient. If it's more efficient, it's less wasteful, whether that be man hours or materials, it's still less waste."

The eco-efficiency technical innovations impacted on the organisations involved and proved to be highly revealing;

"It was all by communication. The things that we learned during the process were eye openers to everybody. We learnt about the product. We learnt about things that weren't compatible. We learnt about frustrating things that wouldn't work. We learnt about the commercial aspects that wouldn't work. We learnt about all of those things. But at the end of it, we came up with something that was better than what was before. And also we learnt a lot about each other. We made contacts, and we could have picked up something else and done exactly the same thing again."

In spite of the enthusiasm generated, the supermarket retailers demanded the product in sufficiently high volumes to reduce the unit price. This was impossible to achieve with an experimental product, and they were effectively blocked;

"We weren't able to convince the marketeers to give it shelf space to pilot that (the bottle) as an environmentally friendly product."

The supermarkets refused to label it as a 'green' product because the 'greenness' referred to the packaging rather than the contents.

(Figure 4.9 continued)

The reasoning for this was given as;

"The marketers said 'I don't think the environmental issue will enable us to move the product in the volumes required to justify the shelf space'".

One supermarket offered a concession;

"On the other hand, they said if we could fill all our bottles, every single one this way, and not label it an environmentally friendly product, then we might take it."

This demanded prohibitively large quantities of materials, such as recycled plastics, to gain economies of scale and reduce prices below those of conventional packaging. Further cost reduction became impossible without including the contents. For it to be marketed as a 'green' product, both bottle and contents had to contrast with conventional goods.

4. 6. Summary.

This chapter has reviewed some of the key issues facing small, growth oriented 'green' businesses that have survived the difficulties of the first few years of trading. The analysis has focused on the origins and markets for goods and services, their strategies for achieving growth and development, general environmental issues affecting the businesses and finally the innovation process. The key findings are summarised below.

- The firms emulate larger enterprises in structure and operations, and are not necessarily innovative in their approach to management.
- The 'green' products selected represent diversification of an existing business or the foundations for new enterprises.
- The services are 'green' variants of conventional services.
- Firms exploit niche markets and mainly trades with other businesses. Individual clients can be described as 'metagrumblers'.
- Markets are generally small, but these firms are immune from direct competition.

- Professional recognition by mainstream industries is more important than gaining plaudits from 'green' awards. Such awards could have the effect of marginalising enterprises.
- Growth is expected, and welcomed, by most firms. Different strategies have been employed or anticipated, from recruitment, through acquisition to the formation of alliances and partnerships. This implies markets for 'green' goods and services are increasing.
- Growth has strategic implications for the management of an expanding organisation. Firms may need more formal management structures, and this transition of devolution of responsibility may be a painful process for the founders.
- The service element offered by manufacturers may become an increasingly vital competitive issue in the future.
- Industry management standards, both environmental and non-environmental, received a mixed reaction. Some businesses considered compliance part of an inevitable spiral of increasing competition. Others thought they placed an unnecessary financial burden on SMEs.
- In contrast, the firms were much more positive about environmental regulation. The general view was that compliance, or super-compliance was commensurate with their 'green' image and represented business excellence.
- Unlike the stereotypical image of reactive SMEs, some are engaged in the process of formulating appropriate regulations.
- The key driver for innovation was the identification of new markets coupled with the personal philosophy of the originators and business acumen.
- Quality, not price is the main factor in competition.

In the firms studied, it was evident that competition with either other 'green' businesses or mainstream enterprises was generally avoided. The firms tend to exploit market niches that are largely immune from market entrants, particularly from predatory firms that may pose a threat to their independence in the future. There is greater interest in their goods and services, reflected in the general business optimism. This enables them to achieve two goals. One is to benefit commercially from increased trade. The other is to encourage the 'greening' of the industry. Allied to this position is the understanding that the cumulative environmental benefits of many people making modest changes in their lifestyles and purchasing behaviour has a greater effect than a limited number exploiting 'green' issues to their fullest extent. Some of the firms also exhibited awareness of issues beyond superficial environmentalism, such as the social and ethical dimensions of local employment.

Growth has been viewed as central to most enterprises, and confirms the observation made by Story (1994) that firms that grow also survive. These firms are unlikely to experience high growth rates typical of high technology based firms (Dodgson and Rothwell, 1989), instead choosing to adopt more measured and modest expansion. These SMEs also act as mature enterprises, witnessed by the strategies adopted. Some firms opted for organic growth through recruitment, although this has policy implications, as some enterprises experienced difficulties in locating suitable staff. Other strategies include the formation of alliances or partnerships to increase their technological base and service provision, and have great implications for management strategies.

'Green' SMEs face the same transitional problems of expanding from a small unit as conventional enterprises. They need to appreciate that any expanding organisation requires delegation of management responsibility, and possibly the imposition of formal management structures. Devolution of responsibility is also a key issue, and may be difficult, but vital, for some entrepreneurs to accept. Formal management structures, such as IIP, are more important to manufacturing firms because of the need to co-ordinate resources effectively. Services can expand and operate as a federation of like-minded professionals, as the architects have done, to create a mutually-supporting alliance of 'Associates'.

This strategy in information intensive businesses realises a return to the craft tradition. The alliances of 'Associates' is a co-operative practice in certain professions that need to share experience and expertise. The need to share information is also true of new 'green' services and is facilitated by organisations such as Green Business Clubs. The model might be usefully transferred to other 'green' services and possibly the manufacturing sector.

Some of the strategic factors that determine growth potential of small firms are to be found in the firms studied, which concur with the contention by Storey (1994) that forward planning, appreciation of markets and the introduction of new products appear to be important. The firms are possibly dissimilar to most growth-oriented businesses. They are not viewed as vehicles for the owners to sell to another firm. Instead, they intend to maintain direct interest in the long-term development of the enterprise. Product and service diversification is clearly a prerequisite for expansion. Inevitably, a weakness of a single visit interview project is the inability to verify if, and how, expansion materialised in these firms.

The main innovative drive behind the 'green' companies has been the conversion of environmental or sustainable ideals into commercial ventures, or the expansion of an existing business into a 'green' product market. This is unsurprising given the nature of the sample. Rigorous pre-launch market research is a rare event in these firms, many proceeding despite commercial reservations. This should not be confused with naiveté, as all founders have considerable previous relevant business or technical experience. The firms survive and prosper because they are able to exploit the perceived technical superiority of their products or differentiate with added services, rather than compete in price sensitive markets.

The reactions to regulation and industrial standards is more mixed. Some SMEs find it problematic, others are actively involved in regulatory process. These 'green' SMEs are unlike the stereotype of minimal compliance usually portrayed, and often associate 'super-compliance' with 'Best Business Practice', and in one instance regulatory confusion acted as a spur for innovation. It was noted that services are virtually ignored by environmental regulations beyond the usual work place legislation.

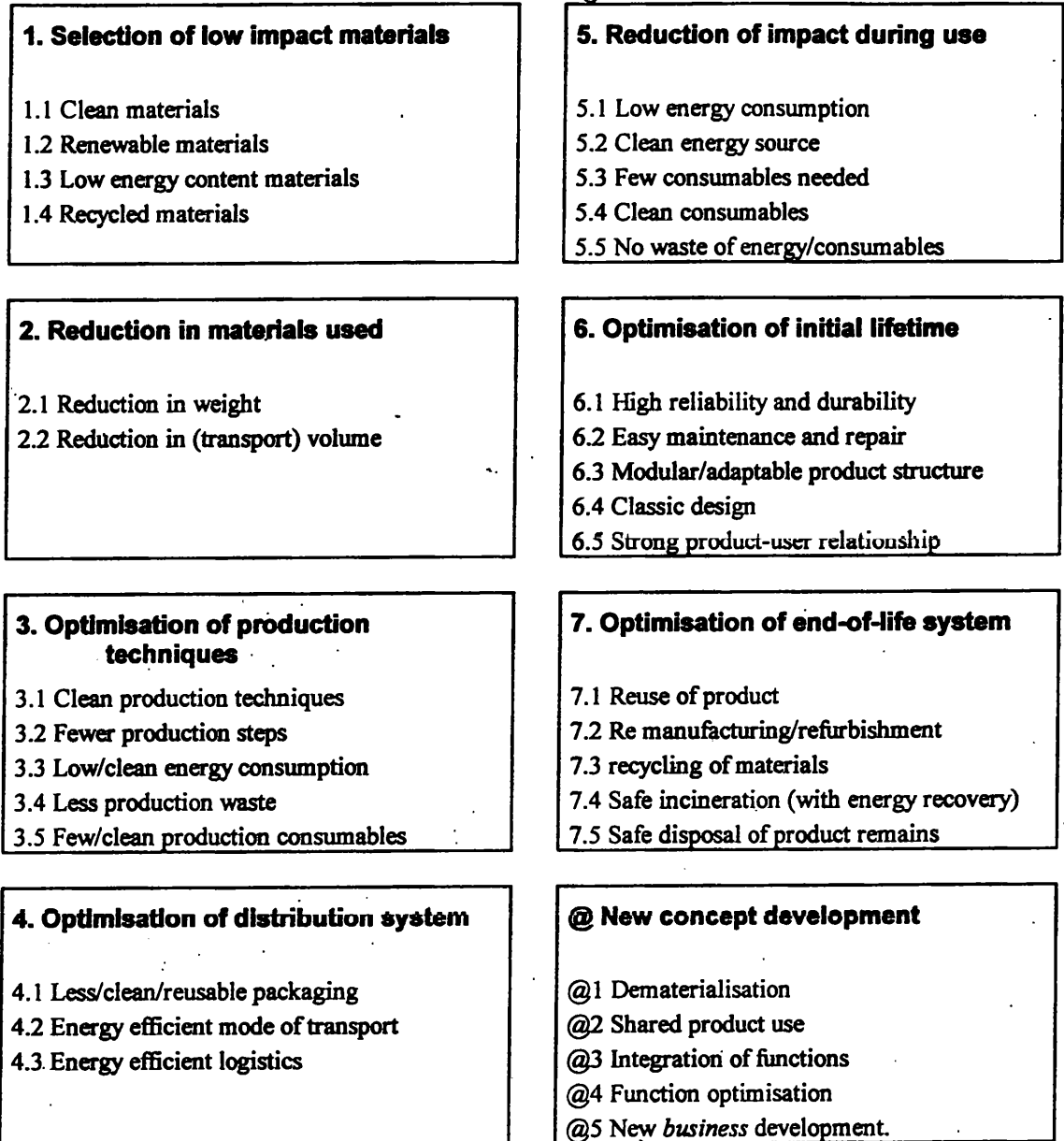
The prevailing picture of SMEs suggests they are generally reactive to environmental issues. This analysis shows that the situation is more complex. The SMEs in this study may not relate well to management systems designed for large firms, but most of these small enterprises have an understanding of environmental issues that penetrates deeper than management systems. The next chapter examines the environmental issues addressed by the 'green' products.

Chapter 5. Design for the Environment (DFE) Strategies.

5.1. Introduction.

This chapter analyses the environmental issues addressed in the design of products, and so refers to six of the case study firms. Briefly, these are the enterprises that produce solar water heating panels, a light-weight detergent bottle, rechargeable batteries, an energy efficient solar powered refrigerator and water conservation systems. The background of the analytical tools used in this chapter are described in Chapter 3 (Methodology). The chapter follows the same of environmental dimensions as the eco-wheel pioneered by Hemel (1998), and considers the sequence of product design issues from low impact materials through to ideas of new, environmental business directions. The final category labelled '@5' has been created specifically to deal with strategic design issues that arose from these case studies, and will be discussed further in section 5.9. Figure 5.1 shows the eco-wheel 34 Design for the Environment (DFE) principles in their respective eight clusters. Detailed analysis of the transcripts revealed information that enabled coding of each element in the six-point scale previously described in Chapter 3. This is replicated here, together with some examples drawn from the interviews to illustrate how the scores were derived for the individual case study firms. These are shown in Table 5.1.

Figure 5.1. Typology of the 34 DFE Principles, Clustered in 8 DFE Strategies.



Source: Hemel (1998).

Table 5.1. DFE Rank and Significance.

DFE Principle Score	Significance and Illustration.
0	Not mentioned or inappropriate.
1	<p>Aware, but very low priority, nothing yet achieved, possibly action planned in the future.</p> <p>Solar Splash has limited control of the final destiny of their main raw material, polypropylene (PP), although it is readily recycled material. They are aware of industry specialists in handling waste material, but acknowledge;</p> <p><i>"We are in the hands of the manufacturers of the polymer. We are processing and adding value to the polymer."</i></p>
2	<p>Aware, but no action taken for reasons other than environmental factors (e.g. lack of R&D).</p> <p>EcoChill would like to develop a battery-free refrigerator, and are also investigating solar-thermal technologies, but are restricted due to lack of R&D funds;</p> <p><i>"We are stymied by research and development money. We just haven't got that."</i></p>
3	<p>Limited action taken because of possible negative environmental consequences (potential 'trade off').</p> <p>Solar Tech could use polycarbonate instead of glass in their solar panels. The trade off is that polycarbonate is lighter and has better heat retention characteristics than glass, but is less efficient at transmitting light, and more difficult to replace in the event of breakage.</p>
4	<p>Some action taken and more planned. More scope for improvement if conditions change. Outcome could be driven by non-environmental considerations. Low cost, low benefit actions.</p> <p>Solar Splash uses Poly Propylene (PP) in preference to Polyvinyl Chloride (PVC) for health and environmental reasons. Their plastic pipe extrusion equipment was originally restricted to exclusively virgin material, but they are now able to reuse previously discarded plastic, thus reducing waste, and there is scope for increasing the recycled fraction.</p>

Table 5.1, continued.

DFE Principle Score	Significance and Illustration.
5	<p>Considerable resources committed, much activity.</p> <p>Green Stick has a policy that states that they do not knowingly use materials that damage the environment, and encourages their suppliers to do the same. They also make great use of scrap material that effectively displaces some virgin plastic, and increases their eco-efficiency;</p> <p><i>"This is good business practice that has an environmental benefit, not an environmental issue that creates good business practice."</i></p>
6	<p>Fully committed and explored issue within limits of current technology. Future developments in this area expected.</p> <p>EcoChill devised a solar powered, CFC free, energy efficient, durable, reliable, portable refrigerator for carrying medicines in remote places. The Photo Voltaic (PV) system charges the batteries which store the charge until required, and the next development will be an alternative to lead-acid battery technology for energy storage;</p> <p><i>"The most important part of the fridge is it's energy efficiency. It is the most energy efficient fridge in the world. That's as much for commercial reasons as anything else, which is that if you've got a fridge powered by solar, the last thing you want to do is be wasting any energy because you want to maximise the use of the photo voltaic input...so that you don't have to use too many panels to power it. It's three times as efficient as a fridge that size would normally be."</i></p>

The chapter will discuss environmental profiles of the products in greater detail as outlined in the eco-wheel. The fully tabulated results are shown in Table 5.2.

Table 5.2. Tabulation of DFE Strategies for Manufacturing

Firms.

DFE Principle	Solar Tech	GreenStick	Solar Splash	EcoBatts	Fresh Water	EcoChill
DFE Strategy 1. Select Low Impact Materials						
1.1 Clean materials	0	5	5	4	5	3
1.2 Renewable materials	2	0	0	0	0	0
1.3 Low energy content materials	0	0	2	0	0	0
1.4 Recycled materials	0	2	4	0	5	0
Total (% of maximum score)	2 (8)	7 (29)	11 (46)	4 (17)	10 (42)	3 (13)
DFE Strategy 2. Reduction of Material Use.						
2.1 Reduction in weight	2	5	2	4	5	2
2.2 Reduction in (transport) volume	0	5	0	0	4	0
Total (% of maximum score)	2 (17)	10 (8)	2 (17)	4 (33)	9 (75)	2 (17)
DFE Strategy 3. Optimise Production Techniques						
3.1 Clean production techniques	2	0	2	1	0	1
3.2 Fewer production steps	0	0	1	2	0	0
3.3 Low/clean energy consumption	0	0	4	5	0	0
3.4 Less production waste	0	5	0	0	0	0
3.5 Few/clean production consumables	0	5	0	0	0	0
Total (% of maximum score)	2 (7)	10 (33)	7 (23)	8 (27)	0 (0)	1 (3)

(Table 5.2 DFE Strategies, continued)

DFE Principle	Solar Tech	GreenStick	Solar Splash	EcoBatts	Fresh Water	EcoChill
DFE Strategy 4. Optimise Distribution						
4.1 Less/clean/reusable packaging	4	3	0	4	0	0
4.2 Energy efficient mode of transport	0	0	0	1	2	2
4.3 Energy efficient logistics	0	2	1	0	4	1
Total (% of maximum score)	4 (22)	5 (28)	1 (6)	5 (28)	6 (33)	3 (17)
DFE Strategy 5. Reduction of the User Impact						
5.1 Low energy consumption	0	4	0	6	5	6
5.2 Clean energy source	3	0	5	6	5	6
5.3 Few consumables needed	0	4	0	0	0	0
5.4 Clean consumables	0	0	0	0	5	0
5.5 No waste of energy/consumables	4	0	0	6	0	0
Total (% of maximum score)	7 (23)	8 (27)	5 (17)	18 (60)	15 (50)	12 (40)
DFE Strategy 6. Optimisation of initial life.						
6.1 High reliability and durability	6	6	6	6	5	5
6.2 Easy maintenance and repair	6	0	4	6	5	1
6.3 Modular/adaptable product structure	0	0	0	0	0	5
6.4 Classic design	0	0	0	0	0	0
6.5 Strong product-user relationship	0	0	0	0	0	0
Total (% of maximum score)	12 (40)	6 (20)	10 (33)	12 (40)	10 (33)	11 (37)

(Table 5.2. DFE Strategies, continued)

DFE Principle	Solar Tech	GreenStick	Solar Splash	EcoBatts	Fresh Water	EcoChill
DFE Strategy 7. Optimisation of end of life.						
7.1 Reuse of product	0	6	0	4	4	1
7.2 Remanufacturing /refurbishment	0	0	0	0	0	0
7.3 Recycling of materials	4	5	1	4	4	2
7.4 Safe incineration (with energy recovery)	0	0	0	0	0	0
7.5 Safe disposal of product remains	0	0	0	0	4	0
Total (% of maximum score)	4 (30)	11 (37)	1 (13)	8 (27)	12 (40)	3 (10)
DFE Strategy '@'. New Business Development						
Total (% of maximum score)	2 (33)	4 (67)	1 (17)	3 (50)	4 (67)	3 (50)

5.2. DFE Strategy 1. Selection of Low Impact Materials.

The first aspect of the eco-wheel is intended to direct product design towards more sympathetic use of environmentally-friendly materials. Some of the options available are shown in Figure 5.2.

Figure 5.2. DFE Strategy 1. Selection of Low Impact Materials.

The aim is to use the most environmentally harmless materials and surface treatments for the product. The practicality of this option may depend on the product life cycle.

1.1. Clean materials. Some materials and additives should be avoided because they cause hazardous emissions during production or disposal. Some toxic materials are banned.

1.2. Renewable materials. Materials obtained from sources that are not replenished naturally. Some minerals may eventually become substituted by alternatives due to the rising costs of extraction or recycled. The exhaustion of fossil fuels for energy generation may then be regarded as a serious problem.

1.3. Low energy content. Some materials have a high 'energy content' because the extraction and production are very energy intensive. Use can be justified if it leads to other, positive environmental product features.

1.4. Recycled materials. These are materials that have been previously used. If suitable, they ensure that the energy used in their manufacture is not lost.

Source: Adapted from Hemel (1998).

The scores derived from the interviews indicate that most action by these firms has been to use 'clean materials' and recycled materials where possible. This may reflect the level of knowledge of recycling issues or regulatory activity in promoting recycling. Conversely, there is little evidence that effort has been directed at locating renewable or low energy content materials, possibly due to the lack of interest in, or shortage of these goods.

5.2.1 Selection of clean materials.

A good example of a firm committed to reducing reliance on hazardous materials is GreenStick, the label manufacturer. They observed the strong link between environmental and health and safety issues.

Their policies are being reviewed to improve handling of toxic materials coupled with a switch from organic solvent to water based inks, and will be reflected in their management procedures;

"We're looking at our quality manuals and our health and safety manuals as being core working procedures for the company. And out of that are coming lots of environmental issues."

In many cases, technically preferable material also happened to be environmentally superior. For example, Solar Splash uses polypropylene (PP) rather than polyvinyl Chloride (PVC), a highly contentious plastic. PP panels are very efficient collectors of solar radiation, and resistant to swimming pool chemicals. It outperforms metal radiators because although metal radiators can withstand higher water temperatures, metal panels are prone to corrosion. In contrast, PP is highly durable and is lightweight. EcoBatts replaced the original battery packing foams with a CFC-free compound ahead of legislation to prohibit ozone depleters. The internal construction of the battery does have implications for the recyclability of the product, and will be discussed later.

Availability and cost of environmentally preferable materials can compromise choice. Fresh Water makes extensive use of PVC pipe, not only because it is easy to manipulate, alternative materials are either too expensive or unavailable in appropriate sizes. They would prefer to use High Density Polyethylene (HDPE) or natural materials, such as clay. Some of their clients insist on using such materials irrespective of cost, but there may be disadvantages;

"Some people will use natural materials at all costs, even if the energy efficiency is not so good."

The interviewee was aware of the potential environmental trade off incurred by the use of high embodied energy content of some materials.

5.2.2 and 5.2.3 Renewable materials and Materials with low energy content.

There is little evidence that any of the firms had considered these two aspects. Solar Tech made extensive use of copper piping, a readily recyclable metal, in their solar panels. They were aware of the embodied energy of copper because of the process of mining, transporting, smelting and refining. The firm stated it has superior thermal conductivity properties compared to steel. A similar argument has been used by Solar Splash, who used materials with high energy content, such as aluminium and PP.

Aluminium is used in the support structure of the solar panels because of its high strength and low weight. The firm appreciated the environmental implications of importing plastics but commented that there was no UK supplier of PP of the appropriate type and both PP and aluminium are easily recycled.

5.2.4 Recycled/Recyclable Material.

Half of the firms commented on the technical limitations imposed by recycled material. For example, Solar Splash was originally restricted to using exclusively virgin material in the extrusion process, but high quality recycled polymers are now available. GreenStick is limited by health regulations that govern the manufacture of containers and limit the amount and location of recycled plastics used in bottles. Current legislation is framed such that bottles containing recycled polymer have to comprise three layers, where the recycled layer is contained in a sandwich of virgin material. This is because there is an extremely small risk of the bottle contents being contaminated from shredded, recycled polymer. Relaxation of the regulation would permit greater use of recycled material. Fresh Water makes considerable use of recycled material, particularly plastic pallets for drainage bases and thought there is considerable scope for improvement.

5.3. DFE Strategy 2. Reduction of Material Use.

This DFE strategy relates to the aim of reducing material usage, and consequently lead to environmental benefits. These principles are summarised in Figure 5.2.

Figure 5.3. DFE Strategy 2. Reduction of material usage.

This can have implications for reducing the volume and weight of goods transported. Excessive efforts to reduce weight may compromise product performance.

2.1. Reduction of weight. Reduced material directly affects the environmental impacts of a product. It can mean less waste and reduced impacts of transport.

2.2. A greater number of less bulky products and packaging can be transported.

Source: Adapted from Hemel (1998).

There is slightly greater emphasis on reducing weight rather than the transport volume. For most firms, in eco-efficiency terms, the benefits of light-weighting are commensurate with financial benefits, as they need to buy less raw material.

Some interviewees thought that their choice of materials restricted their potential for reducing product weight. Only one firm, GreenStick had realised the benefits of reduced transport volume and tried to communicate such advantages to each partner in the supply chain.

5.3.1 Reduce Weight.

GreenStick commented that the economic benefits derived from reducing raw materials permeate through the supply chain. Their decision making was coupled with a commitment to environmental values;

"We decided the less we used, the more environmentally friendly it would be. We as manufacturers have some small responsibility."

For EcoBatts, a light weight product is considered easier to handle, so ergonomic consideration coincide with environmental advantages. There may be environmental disadvantages from switching materials. Solar Tech had contemplated using a lighter alternative to glass in their solar collecting panels. The trade-offs in switching to twin wall polycarbonate construction are reduced light transmission balanced by better heat retention and reduced panel weight. Glass is preferred because if damaged, it is readily replaced (see also DFE Strategy 6).

Regulations have also limited the scope for material reduction. Solar Splash claimed that compliance with standards that regulate pipe dimensions prevents reducing the thickness of the copper tubing used to connect their solar panels. Weight reduction does not always lead to environmental benefits. Some of their sewage treatment systems designed by Fresh Water use considerable amounts of aggregates as filter beds. They have considered the financial implications of reducing costs through reducing weight, but acknowledge the compromise between the high embodied energy of aggregates is balanced by the low energy consumption in use (see DFE Strategy 5).

5.3.2 Reduction of (transport) volume

GreenStick and Fresh Water were the only firms to comment on this aspect. The latter try to reduce the impact of transporting large volumes of aggregates by using locally available material, which also reduces the embodied energy. The interviewee commented that this is analogous to the determination of the optimum amount of insulation in buildings.

5.4. DFE Strategy 3. Optimisation of Production Techniques.

It can be highly effective to select production processes that have low environmental impacts, and this principle can be amplified by encouraging other actors in manufacturing networks to also adopt similar practices.

Figure 5.4. DFE Strategy 3. Optimisation of production techniques.

This DFE strategy requires production techniques that focus on those that have a low environmental impact. This could be low consumption of non-hazardous auxiliary materials, low losses of raw materials and processes that generate minimal waste.

3.1. Choose alternative production techniques. If possible, select those with the least environmental impact.

3.2. Fewer production steps. Aim for the least number of techniques.

3.3. Low/clean energy consumption. Aim to reduce the energy consumption of existing production facilities.

3.4. Less production waste. Optimise existing production to reduce waste and improve material efficiency.

3.5. Few/clean production consumables. This aims to reduce the amount of production consumables or operation materials, which should be preferably non-hazardous.

Source: Adapted from Hemel (1998).

The interviews suggest that overall the enterprises focus on reducing energy consumption in manufacturing, clean production processes, or reducing manufacturing waste, largely driven by clear commercial benefits.

5.4.1 Alternative Production Techniques.

Two firms commented favourably about improving production and exploring alternative techniques. The pipe moulding process used by Solar Splash is very inefficient due to the age of the machinery, although it is capable of delivering high volumes. Practical reasons prevent investment in more efficient technology. New equipment could process their current annual production in one batch. A similar problem faces Solar Tech, who operate equipment at sub-optimal efficiency and are unable to realise the benefits of economy of scale, but are constantly searching for alternative manufacturing techniques.

EcoChill in effect sub-contract production of their refrigerator to an established refrigerator manufacturer. They exercise limited influence over production but it is not a high priority issue.

5.4.2 Fewer Production Steps.

It is notable that this issue has been almost ignored. Only one firm, EcoBatts, commented on their efforts to streamline the production of batteries by designing the casing with apertures and pins to locate circuitry. Automation is only justified at higher levels of production.

5.4.3 Low/Clean Energy Consumption.

Solar Splash commented that although they manufacture passive solar heating equipment, this renewable energy source is not used for heating the factory;

"We don't practice what we preach."

Instead they focus on energy conservation measures, such as using plastic curtains in doorways. Ironically, the drive for energy efficiency has been compromised due the installation of a new extruder, which although is very efficient and doubled production output, has significantly added to their electricity consumption. EcoBatts are more consistent in their practices. Their purpose built premises are highly insulated, and they ensure energy conservation through 'good housekeeping' practices, such as turning off lights.

5.4.4 Reduced Production Waste.

GreenStick was quite clear about the motives for reducing waste and consumables;

"This is good business practice that has an environmental benefit, not an environmental issue that creates good business practice."

They maximise the use of scrap material that displaces a proportion of virgin material. They have adopted 'Environmental Best Practice' where appropriate, and they are conversant with the environmental impacts of their operations. Like the other enterprises, the firm considers;

"We're business first, environment second."

They have managed to realise cost savings through their management of the supply chain, although their product innovation was commercially unsuccessful. The firm appreciates the 'good business practice' and financial benefits from reducing waste;

"We have completed an exercise where we've tried to minimise waste on a particular job which will have benefits because it will come back into the business, and also benefit the environment."

There are technical limits to waste to reduction strategies. GreenStick produce plastic labels attached to backing paper, leading to both plastic and paper wastage. They have tried without success to develop an unbacked label that would have considerably reduced their paper consumption.

5.4.5 Fewer/Cleaner Consumables.

For just one firm, GreenStick, the main driver is cost reduction through reducing the amount of materials used. They are investigating the potential for introducing 'Best Practice' to reduce ink consumption, and have substituted water based inks for solvent based inks. The inks are cured by Ultra Violet (UV) light, the printing process requires very little water, which is expected to decline further following the introduction of more sensitive dyes.

5.5. DFE Strategy 4. Optimise Distribution.

Optimising the distribution system includes choosing the most efficient mode of transport to deliver goods from the factory to the retailer and the consumer, and this option includes consideration of packaging, a product in its own right. The principles are outlined in Figure 5.5.

Figure 5.5. DFE Strategy 4. Optimising the distribution network.

The distribution system for components should also be considered. Packaging constitutes a separate product group.

4.1. Minimise/clean/reusable packaging. Waste and emissions can be saved by reducing packaging, which will also reduce material and energy consumed in transport.

4.2. Energy-efficient means of transport. The mode of transport can have a major effect on energy consumption.

4.3. Energy-efficient logistics. The environmental impact of distribution can also be reduced by ensuring that the mode selected is used to maximum capacity, and the logistics system is optimised.

Source: Adapted from Hemel (1998).

In general, the interviewees thought they could exercise little control over their distribution networks, and most effort is directed at optimising packaging.

5.5.1 Less/clean/reusable packaging.

Half of the firms had made some effort to reduce the impacts of their packaging. Solar Tech reused most of the original packaging surrounding the raw materials for packing around the finished solar panels, as they found that five of them fit precisely. These are then transported for painting. GreenStick use shrink wrapping that is becoming lighter and stronger, which will eventually render secondary packaging on pallets redundant. They have also taken the unusual step of negotiating with their supplier about the use of recycled, reusable plastic pallets, which produce less dust contamination than the wooden alternatives. There is a trade off between the two types of pallet, because although plastics are inherently less environmentally friendly than wood they are more durable. EcoBatts can afford to use simple packaging because their products are sold to distributors rather than directly to consumers. They sell to distributors, so the issue of packaging is shifted down the supply chain. EcoBatts have stopped overprinting the plastic bags, and there is constant effort being made at saving materials through using smaller, thinner bags or recycled packaging. Most equipment leaves the premises in plastic bags or cardboard boxes, while additional expanded polystyrene is demanded for bulky overseas shipping. The cost of packaging is their main concern, but intend to raise the issue of recycled packaging with their suppliers. They argued that for companies with modest turnover the cost of packaging is disproportionate to the value of the product.

EcoBatts were also very sceptical about the environmental impact, economic viability and effectiveness of recycling in the UK. With reference to the distances waste paper is transported, he commented;

"It still hasn't been proved to me, ... this recycling thing. It seems to be religious zeal on the part of the people that promote it, rather than something that can really be proved to have the effect they say it does on planet earth."

5.5.2 Energy Efficient Transport.

In practice, few firms are able to exercise control over the mode of transport used to distribute their goods. Two firms, EcoBatts and EcoChill mainly use shipping for exporting goods. EcoChill occasionally resorted to air-freight because of the need for rapid delivery, but would ideally use a rail link to the shippers. This might have the effect of increasing prices and risk sales. The refrigerators are finally delivered overland by Jeep or truck, and although they would like to use the most energy efficient transport available, the interviewee observed;

"You can't take a fridge on a bike!"

5.5.3 Energy Efficient Logistics.

Three of the firms commented on the problems associated with product distribution. GreenStick observed that many similar firms are compromised in their efforts to improve logistics because of the demands imposed by Just in Time (JIT) techniques and inefficient distributors. For example, they now receive more frequent, smaller deliveries. Although the weight of each delivery can be reduced, the advantages are lost by the increased frequency of deliveries. The interviewee commented on the limitations of their environmentally focused practices;

"This unit is very efficient by being very environmentally friendly. That's fine within the four walls of this place, but it's creating more transport outside."

The demand for greater levels of service has lead to more pressure on the distribution networks.

The increased activity requires greater energy consumption and leads to contradictions;

"We are driven by market forces at the end of the day. There, you've got a contradiction, where market forces are asking us to lightweight things to get costs down. But they're also asking us to distribute far more rapidly (because of the) Just in Time mentality. So whilst we might be reducing the product and getting the pricing down, the service levels have gone up."

It could be argued that increased service levels constitute waste. Historically, GreenStick was able to stockpile products for up to two weeks, but this is now down to one week. They argued that if their customers could rationalise their buying policies, they could maintain the efficiencies gained, and control the distribution costs. Current pressures have meant that transport costs have increased significantly, and this is unlikely to change in the near future. Solar Splash also believed they were also unable to exercise any direct influence on their distributors and noted;

"It is an incredibly inefficient way of operating. These distributors do not carry stock in sufficient depth."

They thought distributors wanted delivery of single items, so the cost of carriage is disproportionately high relative to the value of the product.

5.6. DFE Strategy 5. Reduction of the user Impact.

The way in which a product is used, maintained and repaired can be an important variable when considering the total environmental impact over its life.

Figure 5.6. DFE Strategy 5; Reduction of the user Impact.

LCA's have shown that for products that consume energy during their use, this stage is the most significant environmental impact.

5.1. Ensure low energy consumption. This can be achieved by choosing low energy or energy efficient components. This stage can have a significant effect on the CO₂ emission profile of an energy consuming product.

5.2. Choose a clean energy source. This can reduce environmentally undesirable emissions.

5.3. Reduce the amount of consumables required. The design should require few consumables for proper functioning.

5.4. Choose clean consumables. Auxiliary products or consumables also have their own life cycle, each requiring DFE analysis.

5.5. No waste of energy or consumables. A product can influence user behaviour, and efficient use can reduce material consumption and waste.

Source: Adapted from Hemel (1998).

The areas addressed by most firms reflect their general concern for reducing energy use or promoting renewable energy sources. This is a function of the products selected for this study. Less attention has been devoted to reducing the impact of consumables. Consumables are the materials and energy required for the product to function when in use. For example, a torch needs batteries.

5.6.1 and 5.6.2 Low Energy Consumption; Choose a Clean Energy Source.

Low energy consumption and clean energy sources are important aspects of the firms selected in this study. Both Solar Tech and Solar Splash argued that the aim of their solar water heating systems lead to reduced fossil fuel use. Conventional heating systems could then be relegated to an auxiliary role. Solar Tech was more circumspect about the capacity of their systems to displace fossil fuels. He suggested that an energy analysis of solar heating would probably reveal that there is very little to be gained, after comparing of the energy required to manufacture the panel to the amount of energy saved through use;

"When you think about the amount of pollution and energy which are used to create the system, I don't think it's worth it."

Fresh Water acknowledged that the operating costs of water purification systems can be an important factor, and some systems may demand the use of auxiliary electrical pumps. The final destination of the treated water determines how much effort is directed at purification;

"There is no point in producing drinking water when it's going into the middle of the North Sea."

EcoChill's solar powered refrigerator combines high efficiency with electricity generated from a renewable source. Their design is independent of fossil fuels in operation. These design requirements were clearly articulated;

"The most important part of the fridge is it's energy efficiency. It is the most energy efficient fridge in the world. That's as much for commercial reasons as anything else, which is that if you've got a fridge powered by solar, the last thing you want to do is be wasting any energy because you want to maximise the use of the photo voltaic input...so that you don't have to use too many panels to power it. It's three times as efficient as a fridge that size would normally be."

The refrigerator is as efficient as possible given the limitations of the technology. The performance is possibly compromised by the location of the compressor and the style of the freezer cabinet. Relocating the compressor may improve cooling of the refrigerant.

5.6.3 and 5.6.4. Reduce the amount of consumables required; Choose clean consumables.

EcoBatts reflected on the capacity for their rechargeable batteries to prevent conventional disposable batteries from being deposited in landfill sites and commented;

"It's going to have a big impact on the environment. They are going to save literally hundreds, and probably thousands of throw away equivalents. This is going to have a big impact in terms of initial resources...the impact of disposing of thousands of dry batteries compared to just one of ours, the energy used in making the thing and disposing of it."

This was the only firm that commented that their products have the potential to save waste.

5.6.5 No waste of energy or consumables.

In this final category only Solar Tech commented on how consumers influenced the effectiveness of the solar water heating systems. Efficiency was strongly affected by the patterns of use of hot water, which is closely related to house occupancy patterns. The energy collected through the solar panels has to be stored and used appropriately. Calculating the 'payback' period to determine feasibility of investment in the system presents major uncertainties. This is further complicated by fluctuations in the amount of solar energy received, for example due to latitude. Variations from the optimum siting and exposure affect the degree with which it can replace a conventional boiler.

5.7. DFE Strategy 6. Optimisation of Initial Life.

The objective of this DFE strategy is to extend the technical and aesthetic life of a product. This will have the effect of increasing the effective use of a product making it less likely to be prematurely replaced to save resources. There may be a balance between increasing the life of a product at the expense of introducing new, more environmentally efficient alternatives.

Figure 5.7. DFE Strategy 6. Optimisation of initial lifetime.

In general, it is preferable to extend the useful life of a product.

- 6.1. Increase reliability and durability. These are familiar goals for product designers.
- 6.2. Ensure easy maintenance and repair. It is important to ensure the product is kept in optimal condition.
- 6.3. Ensure a modular, adaptable product structure. A modular structure permits the substitution of new technical or aesthetic features, allowing it to meet the needs of the user.
- 6.4. Aim to achieve a classic design. Avoid fashionable designs.
- 6.5. Ensure a strong product-user relation. Users will spend effort in maintaining a product about which they care.

Source: Adapted from Hemel (1998).

The interviews revealed that high reliability and ease of maintenance were key design objectives because of the competitive advantage offered. Of the three other design objectives, modular structure, classic design and strong product-user relationships, only EcoChill explored the first, but this has yet to be realised.

5.7.1 Increased reliability and durability.

All the firms interviewed in this study have developed products designed to be both reliable and durable. For example, Solar Tech and Solar Splash use copper, glass and Poly Propylene in their solar panel systems. Both firms were confident that they are extremely reliable, low maintenance systems, providing they are correctly installed and pressure tested. It was claimed the plastics used do not degrade even after prolonged exposure to UV. Solar Splash explained that their system is very simple and robust;

"It's very simple. You can't claim this is highly sophisticated technology. It's not!"

PP is a highly durable plastic, and the panels are only prone to mechanical damage, although exposure to high temperatures can reduce the life span. In practice water temperatures inside the panels rarely exceed 30C. Similar high standards are evident in the rechargeable battery developed by EcoBatts. They claimed that it is constructed to extremely high electrical and mechanical standards, and extremely durable, easy to use and maintain. These qualities were part of the initial design concept, which included integrating the charger within the battery. This system is much more robust than non-rechargeable and other rechargeable batteries. Both Fresh Water and EcoChill have developed products that are designed to be durable and have avoided built in obsolescence. The practical life span of a reed bed is unknown, while the refrigerator is also well designed regarding longevity. These products have been designed for reliability. The design incorporates a twin compressor system, one for each internal compartment. The advantages are that ice can be produced on one side, and vaccines or other medicines stored on the other. This allows vaccines to be packed in ice and delivered to most remote communities by foot, thus extending the 'cold chain'. In the event of one compressor failing, the other compartment can be used for storing vaccines. Again, economic objectives coincide with environmental design goals.

5.7.2 Easy maintenance and repair.

The two solar heating system manufacturers both addressed the issue of maintenance. One system is widely exported to the tropics, and these panels are fitted with glass, which is readily obtainable. The system made by Solar Splash can be drained in winter to avoid water expansion causing burst pipes, which presents the main maintenance problem. Because Fresh Water offers a novel, experimental technology in reed beds, part of the service provision is that the company effects repairs when needed.

5.8. DFE Strategy 7. Optimisation of end of life.

The end-of-life of a product refers to the stage where it needs to be disposed of or reused. It is environmentally preferable to reuse valuable components, and generally 'close material loops' to reduce impacts. This can be achieved through total reuse, or by reusing individual components or recycling materials to make new products. If this is impossible, safe disposal should be guaranteed.

Figure 5.8. DFE Strategy 7. Optimisation of end of life.

Product disposal is a complex issue. 'Closed' material loops are a laudable aim, but particularly problematic for small firms. Reuse can ensure that the energy and materials in a product are not wasted.

7.1. Stimulate reuse of the entire product. This aims to reuse all or part of the product for the same or alternative purposes. The more material retained, the greater the environmental benefits depending on take-back and recovery systems. In the case of technical obsolescence, this option is not recommended.

7.2. Stimulate remanufacturing and refurbishing. This should be explored as far as possible to avoid landfill, as many sub-assemblies can be reused.

7.3. Stimulate material recycling. 'Design for disassembly' is becoming a more common option for designers.

7.4. Stimulate safe incineration with energy recovery. If reuse or recycling is not viable, the next best option is incineration with heat recovery or 'thermal recycling'.

7.5. Ensure the safe disposal of product scrap. If none of the above are possible, safe disposal is essential.

Source: Adapted from Hemel (1998).

End-of-life considerations are not generally a high priority for the firms. The only DFE principles explored were reuse or recycling. If these firms have considered any aspects concerning the end of life of their products, they are likely to have addressed the problems of recycling materials. None of the firms had considered the potential for refurbishing their products or the impacts of energy recovery from incineration. This may be because the firms are too small to implement a recycling system, and may require an industry-wide initiative.

5.8.1 Stimulate reuse of entire product.

EcoBatts furnished clients with information about recycling their batteries and arranged this facility, but to no avail. They stated that many customers claimed recycling was an important issue, but none have taken advantage of the programme. The interviewee was also sceptical of the effectiveness of other recycling schemes, including positive impact schemes, which use vouchers as an incentive.

5.8.2 Stimulate material recycling.

Most firms regarded the materials used in their products as recyclable, but the extent to which they have encouraged or promoted recycling is limited. GreenStick's bottle was designed with reuse and recyclability as a design feature, and 50% of the components of one type of solar panel can be recycled. The PP plastic from the other solar panel is a readily recycled material, and can be easily converted into, for example, shopping bags or car bumpers. This firm is limited in the extent to which such materials are recycled in practice, as they have no control over the end use, and the polymer may be dumped in a landfill site. EcoBatts considered that it would be possible, but economically unfeasible to recycle the electronic components in their batteries due to the complexity of the materials in the circuitry. Firms such as Fresh Water and EcoChill have no experience of their respective products reaching the end of their useful lives. The EcoChill refrigerators are designed such that material can be repaired and reused, although such issues were probably not consciously considered by the designers. The interviewee thought that given the locations where these refrigerators will be used coupled with the ingenuity of the users, many of the parts would be reused;

"The most remote situations is where they tend to be the most ingenious about recycling things."

It was unknown if the designers had thought about such possibilities for reusing the PV panels as an energy source for alternative applications.

5.8.3 Safe disposal of product remains.

Only Fresh Water commented that a natural consequence of their reed bed systems was that they eventually become oak forests through the ecological process of succession.

5.9. DFE Strategy @. New Concept Development.

The symbol @ has been used to indicate an entirely different set of strategies to the other seven. The focus is to explore new solutions for specific needs from a functional and environmental perspective. A distinction needs to be drawn between new business development and new concept development. The latter category combines four design aspects. The former has more profound implications for business evolution, such as a company shifting from selling products to providing a service. This aspect is concerned with sustainable design strategies, and proved to be the most problematic area to discuss and analyse. As a result, a new category (@) was created to encapsulate ideas about general business directions from an environmental perspective. The inclusion of the new DFE strategy relates to the more advanced 'sustainable design' concepts. It refers to Brezet's (1997) category of functional innovation and system innovation responses. The individual elements embodied in the DFE score are impossible to determine from the transcripts.

Figure 5.9. DFE Strategy @: New concept development.

- @.1. Dematerialisation. This relates to replacing the physical product with an intangible substitute that fulfils the need.
- @.2. Shared use of the product. Shared ownership can increase the efficiency of its use.
- @.3. Integration of functions. Material and space can be saved through integrating several functions into one product.
- @.4. Functional optimisation of product (components). Examination of a product may reveal superfluous functions. Auxiliary functions may be realised in a more effective way.
- @.5. New business development. Reconfiguring the total product system.

(Source: Adapted from Hemel, 1998)

These firms expressed new business ideas as new product directions, often involving adaptations of existing lines, and has much in common with section Chapter 4 (section 4.5). None of the firms discussed product innovation using the ideas of dematerialisation, shared use, integration of functions or functional optimisation.

The two solar heating firms had contrasting attitudes towards product and business innovation. The first, Solar Tech viewed solar water heating as one strand of a general environmental direction as a part of the business development strategy which included low energy systems such as heat pumps for domestic housing.

The system produced by Solar Splash was originally designed to heat outdoor swimming pools, but the design has proved robust enough for a range of other uses as heat exchangers, including;

- Circulate warm water under plants in a greenhouse to assist propagation.
- Sunk into the ground to pre-warm water for domestic use.
- Immersed into the outflow from a power station to provide warm water for a fish farm.

In each case, the general principle is the displacement of fossil fuels with solar energy. This is a minor part of their turnover and does not attract much design attention. For this reason this firm has decided not to diversify into domestic water heating markets. The rechargeable battery company, EcoBatts, developed around the central idea of exploiting energy efficient technology for creating associated products, including hand held fluorescent lanterns and head torches. They intend to diversify further into novel lighting technologies with largely industrial applications.

GreenStick was limited from reducing packaging weight by the same legislation that prevents the use of recycled polymer in plastic bottles. There is the possibility that some liquids may penetrate the material and become contaminated by the plastic, which is why virgin material is used for the inner and outer layers. It also limits scope for further development of the container in its present form. Extreme light weighting (see DFE Strategy 2) would cause loss of rigidity, and the bottle would become a collapsible pack;

"It would be a totally different thing, and a totally different shape if it was a different material."

The firm was aware that the great majority of design flexibility lies in the container itself. They are not an end product manufacturer can exert limited influence over product innovation, although their approach to negotiating waste reduction through their sector has achieved some success.

Fresh Water wishes to manufacture their own designs locally to obviate the need for imported goods, while EcoChill aims to optimise the present design through the development of a lead-acid battery-less refrigerator.

They are also investigating the potential of solar-thermal refrigerators, but are restricted due to lack of R&D funds;

"We are stymied by research and development money. We just haven't got that."

The lack of investment in R&D is a recurring theme in several firms, and will be explored further in the next chapter. All firms found it difficult to relate to the specific DFE principles rather than new business ideas and directions.

5.10. Summary.

This section summarises the main findings of the DFE analysis of the six product oriented firms. The profiles for each of the case study firms are shown in Figure 5.10. These visual summaries indicate the practices of the firms are not uniform, and none can be described as comprehensively environmentally exacting.

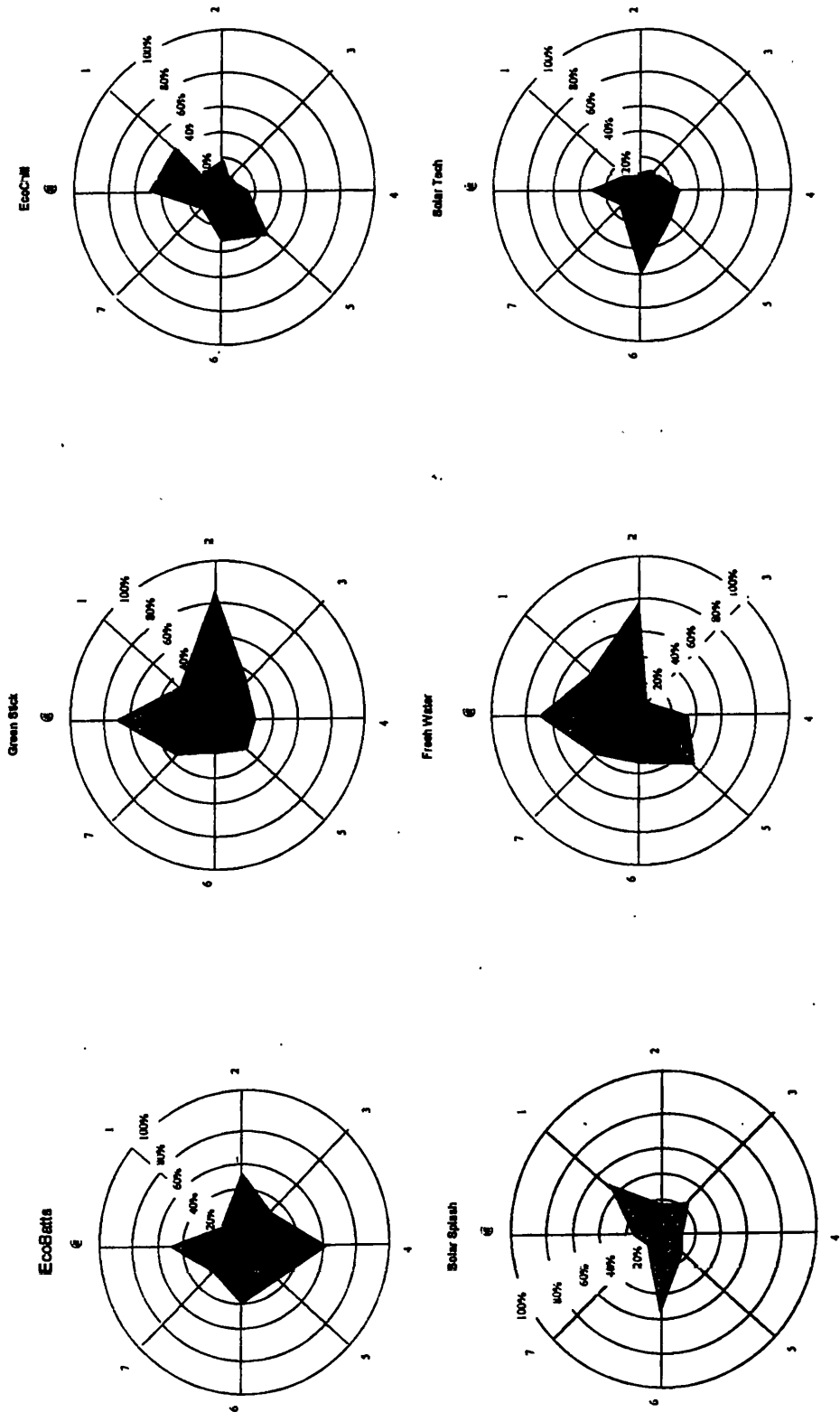
- These SMEs aim to use 'clean' or recyclable material where possible.
- Availability and cost prohibit widespread use of environmentally-friendly materials.
- The most technically appropriate material is often also environmentally superior.
- Use of recycled materials and 'lightweighting' may be restricted due to industry specific regulations.
- There is a close association between the objectives of health and safety legislation in the workplace and environmental goals.
- There is a general focus on eco-efficiency measures in the production systems. Energy efficient and 'clean' processes allied to waste reduction make commercial and environmental sense.
- Eco-efficiency extends to reducing packaging, which is regarded as 'good business practice'.
- Current industrial trends, such as 'Just in Time' compromises efforts at reducing the environmental effects of transport.

- The emphasis on low or clean energy consumption of products in use reflects the nature of this selection of firms.
- High reliability, ease of use, maintenance and repair are key competitive aspects of the products in this study, and coincide with desired DFE characteristics.
- Design for recycling or reuse is not a major consideration for these firms.
- New, sustainable design issues were not apparent. Firms tended to view their innovations as part of a general environmental product strategy, novel applications of existing designs, or the basis of a family of related products.

One of the most striking observations of the design ideas exploited by the firms in this study is that eco-efficiency measures are the most popular choices because rapid economic benefits are consonant with environmental gains. This is also entirely consistent with the idea that 'pollution prevention pays'. The products tend to be robust and reliable, founded on basic technologies, designed for easy maintenance and repair. There is thus a high degree of correlation between ideal design considerations and environmental objectives that provide a competitive advantage. The limitations tend to be imposed by compromises, such as the cost of unavailability of 'green' materials, and potential conflicts between different design objectives. For example, the practice of 'lightweighting' is inappropriate when considering the positive environmental aspects of insulation. A holistic or integrated approach to design is needed to realise the overall costs and benefits of individual actions.

An important environmental issue that firms found difficult to control is transport. Although the firms endeavoured to obtain goods from local sources to reduce the burden of transport, they frequently relied on imported products. This is where commercial benefits are indirect and are not necessarily identified unless very obvious. One firm, GreenStick commented that they are restricted in the degree to which they can influence transport patterns because of the logistical demands imposed by JIT manufacturing techniques that results in frequent, light loads. This contrasts with the efforts to reduce packaging, which has direct commercial and legal implications. With one notable exception, these small firms felt unable to carry environmental benefits through supply chain.

Figure 5.10. The Eco-wheel Profiles for the Products.



Many of these businesses are engaged in small scale, highly specialised technologies. Present business trends increasingly demand higher service levels for the firms to maintain a competitive advantage, and this may have the undesired environmental effect of increasing transport. Several manufactures commented that their current small scale meant they were unable to optimise production processes, introduce automation or realise the full potential of economies of scale. The application of clean energy sources, or efficient use of energy by products is considered important design issues. This is largely a reflection of the selection criteria of the study.

The products featured are all designed to be durable and easy to repair. In contrast, little thought had been given to how the products should be reused, recycled or disposed of at the end of their life. This may be a problem of being a small firm and therefore unable to introduce a recovery system for their products, making 'closed material loops' impractical. There is no experience of the products wearing out or becoming obsolete, so there is no information about the likely effectiveness of material or component recovery programmes, even if the firms were ultimately responsible. Unlike other commodities where product centred material recovery legislation (take-back) is being planned, there is no regulation, and therefore no incentive for any firm to consider the possible economic or environmental consequences of recycling or disposal.

Discussions with these firms indicated that new concept developments proved to be the most problematic to assess. The transcripts revealed that it was impossible to contemplate in detail any of the future DFE options outlined, such as dematerialisation. Instead, discussions turned towards new business directions. These tended to be based on developing applications through extending present technologies or adding to a product family. Some firms were more enthusiastic about innovation than others, and it seemed to depend on how important the technology was to the overall business profile.

The DFE principles that yield economic benefits, largely eco-efficiency related, are those most exploited. Those that are low priority, such as design for recycling, are only addressed when demanded by regulations. The design principles that indirectly produce commercial benefits are often ignored or overlooked. In many instances, good design, business, and economic principles overlap with environmental objectives. The analysis suggests that although the firms were selected on the basis of their environmental product credentials, the principles have been erratically applied. This concurs with the research by Smith et al (1996), that also revealed effort has been

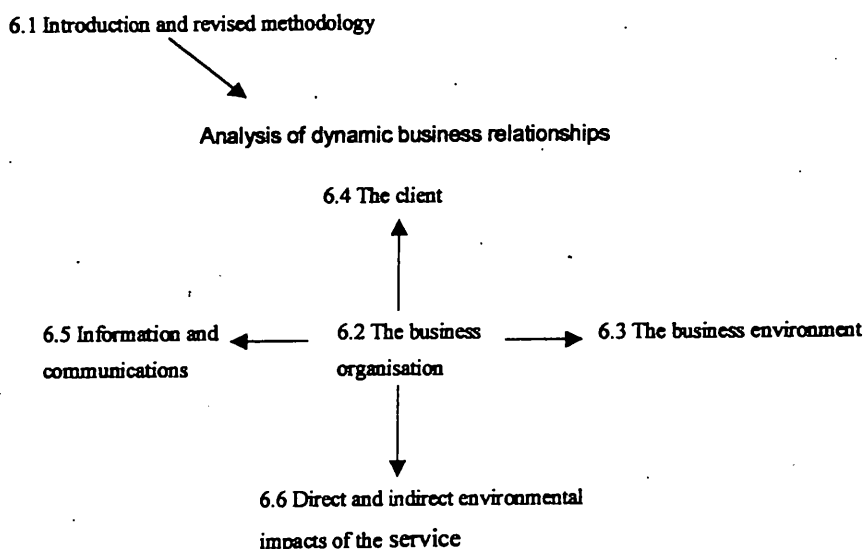
directed at high profile issues, such as reducing packaging waste. Less publicised, but potentially useful ideas, such as reducing components, are almost ignored. This concludes the analysis of the product based firms, and the next chapter deals with environmental profiling of services.

Chapter 6. Analysis of Environmental Impacts of Services.

6.1 Introduction and Revised Methodology.

This chapter builds on the analysis of the environmental profiles of the six product based firms presented in chapter 5. The methodology (Chapter 3) introduced the eco-wheel technique for analysing products. It became clear from inspection of the interview transcripts that the eco-wheel was inappropriate for assessing the environmental effectiveness of services. This is largely because there are two aspects of a service. The first concerns the environmental performance of the internal organisation, such as recycling office paper. The second relates to the way they deliver the service and interact with clients, other professional bodies and others that enable the delivery of that service. All of these can influence, or be influenced by the environmental posture of the organisation. The structure of the Chapter is shown in Figure 6.1.

Figure 6.1 Structure of Chapter 6.



Services are effectively conduits for enabling efficient use of resources, or promoting more environmentally friendly practices through the selective purchase of other goods and services.

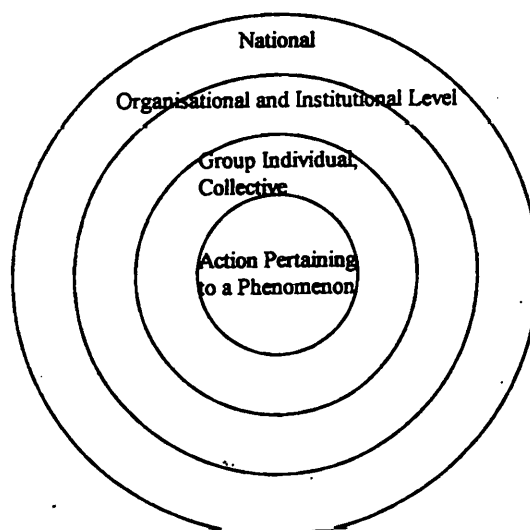
All services are ultimately dependent on tangible products, and the businesses surveyed have shown they are conscious of the nature of those goods. This chapter addresses the revised eco-wheel methodology derived for application to services. The environmental facets of business relations include the organisation, general business environment, the client and finally the environmental dimensions of the goods promoted.

6.1.1 Revised Methodology.

A novel method for handling the information recorded has demanded a new tool that will be applied to the remaining, service oriented firms. It contrasts with product based firms that have tangible goods that can be subjected to some form of LCA, such as the eco-wheel. The ranking system developed for assessing each DFE principle element has been adapted for such an analysis.

For the environmental profiling of services, a contrasting approach to the Eco-wheel was needed. The resultant framework could not have been predicted from the initial eco-wheel analysis of the 'green' products, and the model developed from the data collected provides the basis for future refinement and possible application in other service sectors. It became apparent that a combination of system dynamic thinking (Coyle, 1998) with a conditional matrix (Strauss and Corbin, 1990) and partial networks (Mitchell, 1969) was more appropriate to the task. The conditional matrix model is a graphic way of viewing systems, represented as a set of circles, one nesting inside another, each level corresponds to different aspects of the phenomenon studied. The outer rings correspond to features most distant from the subject, while the inner rings pertain to features most closely bearing upon the subject. The matrix is illustrated in Figure 6.2.

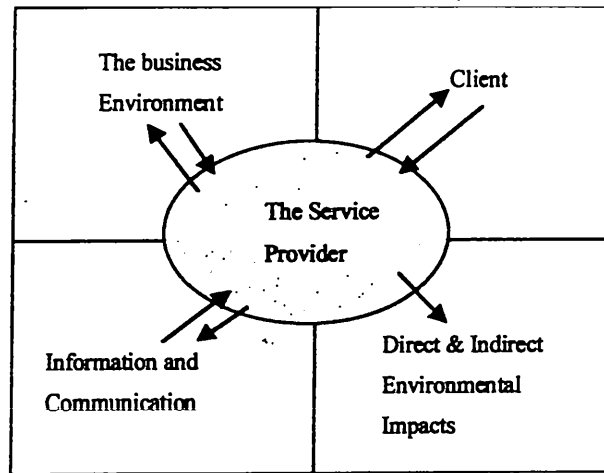
Figure 6.2. The Conditional Matrix (Adapted from Strauss and Corbin, 1990)



This type of analytical framework was more suited to investigating the environmental implications of dynamic relationships within businesses, their professional environment, clients, how they manage environmental information and the environmental impacts of the service itself. Dynamic system modelling offers an approach for mapping the key relationships of an enterprise that have some environmental connotation. The interviews revealed that five major sets of relationships existed that in turn framed their environmental profiles.

Instead of using succeeding layers to represent degrees of separation from a phenomenon, this model presents all the sets of factors as equal. It was largely derived from the 'actor positioning template' approach developed by Conway and Steward (1996) that represents internal and external organisational interactions simultaneously. This variation of the model collapses to two levels. The inner represents the firm itself, and the outer is split into four equally important sections. The four parts are the business environment, the client, information and communication and finally the direct and indirect environmental impacts of the service. The analysis suggests this appears to be a reasonably robust model. The interactions between internal and external factors can be represented graphically, as shown in Figure 6.3.

Figure 6.3. Diagrammatic Representation of Environmental Influence of Service Companies.



The five sections comprise an array of elements, similar to the eco-wheel and DFE principles used in the preceding chapter. The sixteen sub-sets clustered into the five sections are shown in Figure 6.4, shown overleaf. There are essentially two main aspects of the environmental impacts of the service. One relates to the direct environmental consequences of the operation, and includes energy and resource consumption in the offices. The other concerns the wider effects of the service *delivery*. These environmental impacts may far outweigh the direct effects. The analysis used interview transcripts to provide supporting evidence that a firm has considered a particular aspect, and how that factor has influenced the business. The section of the interview schedule that includes the eco-wheel proved to reveal limited useful information in this respect, so other parts of the interview have been used for guidance.

This model analyses the dynamics of the internal and external relationships of the service provider, and the action sets show the linkages between different components. It is beyond the scope of this study to quantify the actual environmental impacts or gains made from the use of these services, unlike a formal LCA methodology. Instead, it is more helpful to highlight the influence the service exerts on both internal, enterprise specific issues, and external business relationships. These include interactions with regulatory bodies, other service providers, such as Banks, information provision and collection and the role of the client. The sets are described in greater detail.

Figure 6.4. Typology of Service Environmental Effects, Clustered in 5 Areas.

<div>1. The Client</div> <div>1.1 Influence On</div> <div>1.2 Pressure From</div>	<div>2. Information and Communication</div> <div>2.1 Information Provided</div> <div>2.2 Information Received</div>
<div>3. Indirect Environmental Impacts of the Service</div> <div>3.1 Materials</div> <div>3.2 Energy</div> <div>3.3 Transport</div> <div>3.4 End-of-Life</div> <div>3.5 Application of LCA Philosophy</div>	<div>4. The Direct Environmental Impacts of the Service (Organisation/Internal)</div> <div>4.1 Philosophy of practices</div> <div>4.2 Environmental Policies</div> <div>4.3 Regulation</div> <div>4.4 New Business Concepts</div>
<div>5. The Business Environment.</div> <div>5.1 Environmental Regulations and Standards</div> <div>5.2 Other Institutions and Organisations</div> <div>5.3 Networks and Suppliers</div>	

The relationships themselves were identified from a review of the interview transcripts. The strength of the relationship was described using a four point ranking scale similar to that devised for analysing the 'green' products. It has been used to gauge the significance of a particular factor to the business and established the degree action taken or influence exerted. In many respects, this is a bi-directional process. A business may not only be capable of expressing concerns, but also be subjected to external opinions.

The coding convention, or ranking system developed to enable classification of the products can be paralleled for services. It can be applied to the 'direct effects' section of the analytical map. Instead of application to individual DFE elements, it has been based on a thematic assessment of the interviews.

This uses a cognition and behavioural ranking scheme to identify degrees of activity or influence on a 0 to 4 ordinal scale. It should be noted that there is no conceptual link between the individual ranks, so a score of 4 does not imply twice the level of activity of a score of 2, although the higher the score, the better the performance.

There is a crucial difference between measures of activity and influence. Levels of activity can be measured directly from assessments of evidence contained within the interviews. In contrast, influence can only be inferred, and is therefore a perceptual measure. Corroboration would entail further interviews with the bodies and organisations referred. The ranking scheme illustrate with some examples is shown in Table 6.1, and the data used in this analysis are shown in Table 6.2.

The chapter follows the themes as arranged in Figure 6.3, and discusses each in turn, starting with the most significant theme, indicated by the highest average score of the components. This ranks the themes in order of relationships with clients, handling information, the indirect and direct environmental impacts of the service delivery, and finally the wider business community.

Table 6.1. Ranking Scheme for Environmental Effectiveness.

Rank	Significance
0	Not mentioned
1	<p>No action or influence, but mentioned.</p> <p><i>"There are limitations that we can't deal with ourselves because of the market."</i></p>
2	<p>Intention for future action or scope for influence.</p> <p><i>"We'd have been on rainwater things probably a long time ago if we hadn't had problems with some of the water regulations. It doesn't comply for one reason or another. They're changing the regulations to make allowances for these things, so there is more flexibility."</i></p>
3	<p>Limited action taken, or evidence for some influence.</p> <p><i>"Ideally we want to not just comply, but go beyond compliance...I think we should be an example. If we are delivering information that advises them on good practice, and we are not carrying out that good practice ourselves, that it ethically wrong."</i></p>
4	<p>Extensive action taken or considerable influence exerted. For example, in relation to waste minimisation, one architect commented;</p> <p><i>"We use everything we can on site, and we lose everything we can on site."</i></p>

Table 6.2. The Environmental Influence of Service Companies.

Element	Green Info	GreenAcres	GreenBuild	EcoBuild	Enviro Shop	Eco Word	Enviro Loot	Greencar Rescue
1. Influence Over Clients, and Pressure From Clients.								
1.1 Influence on Clients	3	2	3	3	3	3	1	3
1.2 Pressure from Clients	3	0	4	3	4	0	3	3
2. Information and Communication.								
2.1 Information Provided	3	2	0	3	3	3	3	4
2.2 Information Attained	3	3	1	0	0	3	3	0
3. Indirect Impacts of Service								
3.1. Materials	3	3	3	3	3	0	3	0
3.2. Energy	3	3	3	4	3	0	0	0
3.3. Distribution	1	3	0	0	3	0	0	0
3.4. End-of-life	0	0	3	4	2	0	1	0
3.5. LCA Philosophy	1	3	4	4	4	0	1	0

(Environmental Impacts of Services, continued)

Element	Green Info	GreenAcres	GreenBuild	EcoBuild	Enviro Shop	Eco Word	Enviro Loot	Greencar Rescue
4. Direct Environmental Impacts of Service.								
4.1 Philosophy	2	4	4	4	4	0	0	3
4.2 Environmental Regulation	3	0	0	0	4	1	1	3
4.3 Environmental Policies	0	3	0	0	3	0	0	0
4.4 New business concepts	2	0	2	0	2	2	0	0
5. The Business Environment								
5.1 Environmental Regulation	3	2	3	2	2	0	1	2
5.2 Inter Industrial Relations	0	3	2	3	0	0	3	1
5.3 Networks and Suppliers	1	1	3	3	0	2	0	2

6.2. The Client.

This part of the analysis of services determines how much influence the service provider felt they could exert over their clients. This is a reciprocal relationship, as clients also exert pressure on the services.

The scores indicate that there is almost equal pressure exerted on as that received from clients to adopt good environmental practices. Most of the service-based firms interviewed for this study felt able to encourage their clients into accepting high environmental standards. That their clients should accept such posturing is hardly surprising, as most chose to conduct their business with these firms because of their own environmental beliefs. The firms show a clear understanding of the nature of their clients and what is likely to motivate them. There is an underlying tension, or balance, as the interviewees felt they were often limited in the degree of influence they could exert.

Both forms of relationships with their clients are important to these firms, reflected in the overall balance and high scores. This section of the chapter reviews the effects of pressure exerted on clients, followed by the environmental standards demanded by clients.

6.2.1 Pressure On Clients.

Six of the eight firms felt able to exert limited influence over their clients, who are typically well informed about environmental issues, previously described as 'metagrumblers' (see Chapter 4). The companies have to be sensitive to the economic and psychological limits of their influence. GreenBuild architect summarised this perception of client relations;

"You can push a client so far, but they are the ones paying for it ultimately."

The degree of leverage they can exert is heavily dependent on a client demanding 'green' technologies. Understanding consumer motivation is crucial, and as an example, Greencar Rescue believed their customers respond more favourably to encouraging, supportive messages.

They also recognise the environmental benefits accrued from large scale, incremental behavioural shifts towards an environmentally friendly life-style, as observed in Chapter 4. This aspect is central to firms whose objective is to change perceptions and behaviour, such as Green Info;

"If we are trying to change people's behaviour, we need to know what motivates them".

They need to be aware of what their clients wish to communicate, and respond accordingly.

The constraints faced in changing industrial client behaviour were encapsulated by Green Info's experiences. They are aware of the inertia in many industries, not least because of investment in technologies and techniques that are not inherently environmentally sound. Their videos have to reflect acceptable incremental, investment strategies. The firm also understands that industry needs to be guided along a 'green' path, starting with legislation and easily implemented projects, such as waste minimisation schemes, before they embark on attempts to communicate eco-design thinking. The problems and frustrations were summarised by the interviewee;

"There are all sorts of things which would make us sustainable...but the reality is that there is a lot of existing capital in equipment, cultures, working systems that people have to travel along this road of education. Often it's the environmental manager that is battling to get this sort of thing on board."

There is always the risk that the messages in their videos are not fully implemented, or the reality is distorted or compromised, as has happened with an engine manufacturer that did not appreciate that emissions from their own products caused major environmental problems. There is a close alliance with this part and the following section that describes how information can be used to induce environmentally friendly behaviour.

6.2.2 Pressure From Clients.

The clients these firms serve reflect the complexity and diversity of the 'green' consumer market. Consequently, the firms have to fulfil a range of conditions. They must be seen to be 'green', deliver economically viable services, and be high quality, competent organisations. The first type of 'green' client, described by Greencar Rescue, is the self-selecting, financially stable environmentalist. EcoBuild are exposed to highly esoteric elements of design, demanded by their clients, such as principles of Feng Shui, wariness of the effects on health of electro-magnetic fields, geo-pathic forces astrology and dousing. Some of these ideas may be currently fashionable, but much constitutes sensible design.

The second category of consumer demands both environmental values with financial advantages. GreenBuild observed this mix of directions from his clients;

"Some people come to me because they want a 'green' architect. They say, we want someone who understands 'green' issues. We don't want to live in a building full of toxic materials. We want it really well insulated, (and) we don't want to be using lots of fossil fuels to keep warm in the winter. Or people come to you purely from a hard headed financial point of view."

The profile of the 'green' consumer is further complicated by environmentalism, which is subsumed within wider ethical issues. For example, Enviro Loot has clients who primarily wish to invest in ethical, rather than environmental projects. The business routinely checks the environmental investment profile of their clients, which helps them to identify and match those criteria with funds that are also profitable. This means investments have to conform to multiple contingencies;

"We have a double bottom line, and sometimes a triple bottom line, because we will sometimes separate out the social and environmental aspects."

The 'triple bottom line' in this context means that the investment should meet minimum standards of financial, ethical and environmental performance, so the company also has to be aware of social issues. The interviewee expressed the opinion that investors should not be penalised for expressing ethical demands.

The third type of client are professional bodies, such as those that visit the Enviro Shop, and are starting to take an interest in the technical competencies of the services offered. This includes representatives from local authorities, county councils, water companies and the Water Regulation Council. These agencies are particularly interested in technical aspects of the rain-water collection and storage systems from a practical perspective and to identify how regulations may be framed to accommodate the technologies.

What appears to limit the extent of pressure from clients tends to be a mixture of scepticism and confusion about the validity of some environmental ideas on the part of the service provider.

6.2.3 Summary.

- The relationship with clients is very strong, and firms are equally able to influence their customer environmental profiles as they are exposed to pressure from them.
- The profile of the 'green' consumers that use these services is a complex mixture of environmentalism, economic sensibility and professional scepticism.
- 'Greening' may be delivered through quite radical ideas or more incremental technologies and behaviour changes.
- Changing consumer behaviour, whether private or corporate client, is crucial and depends on systems that reward rather than punish. This requires a good understanding consumer of motivation and perception.

6.3. Information and Communication.

The collection, processing and dissemination of environmental information are fundamental to all these firms. Like the relationship with clients, it is also a two way process. A core function of several services is the dissemination of information designed to influence their customers and wider public opinion. To a lesser extent, they also depend on gathering information that influences the way the service is delivered.

Most of the services depend on providing and receiving material that maintains their position as 'gate keepers' or enablers. The data collected in the interviews has been analysed using the same format adopted for dealing with their relationships with clients. The first part discusses the way in which environmental information is disseminated present and potential clients. The second addresses the nature and influence of information they receive. It is apparent that the provision or dissemination of information is an important activity, and more so than collecting data.

6.3.1 Information *Provided*.

Definition of unethical, environmentally-unfriendly investment;

"Small, portable nuclear powered child abuse."

(Enviro Loot).

The successful diffusion of 'green' ideas also depend the direct involvement of the enterprises in activities such as environmental reporting, making information available, practical demonstrations of 'green' technology and publicity campaigns. They also rely indirectly on awards, research and the co-operation of other organisations.

The production of information with a strong environmental theme is a core business function of many of these services. There is an obvious commercial benefit arising from generating publicity, and several firms have based their success on highly tuned communication skills. This is exemplified by Greencar Rescue, which publishes an annual report for the membership.

The report details their social, environmental and financial performance, referred to later by Enviro Loot as the 'triple bottom line'. In common with GreenAcres, they also provide a regular newsletter, which provides members with publicity material in support of their campaigns.

The Building Society, GreenAcres, and the Enviro Shop representatives were particularly in favour of more practical demonstrations of sustainable life styles;

"There needs to be more examples shown, and a much faster track system for people who want to go ahead and do it, and are prepared to put their money where their mouth is, or live under those conditions."

The businesses also encourage 'greening' through indirect means. For example, the Building Society and the EcoBuild architect are keen to encourage more research into alternative construction techniques, and professional magazine articles and organisations such as the AECB had the potential to influence non-green architectural practices. EcoBuild also thought that awards, including the Royal Institute of British Architects (RIBA) 'Green Building Awards' and the Times 'Environment Building of the Year' could have a similar effect.

Two barriers were identified that complicated the process of communication. One was the difficulty in communicating complex information, the other an oversimplification of the nature of the 'green' consumer.

The first aspect can be illustrated by Green Info, who specialise in communicating good environmental practice to a business audience. They view themselves as 'gatekeepers' of environmental information, and appreciate the complexity of the subject matter;

"There was a lack of tools or training materials that presented all the environmental issues, in terms of training the workforce. There is a lot of confusion about the global issues."

Their role as 'gatekeepers' is illustrated by the reference to the specific problem of effective communication;

"Often there are solutions available, but people just don't know about them. One of the major barriers about moving towards sustainability faster is a communication problem. That's where I see us fitting in, as translators between all this that's going on successfully, and delivering that to all those people out there that do not yet know, but in an accessible form...through video and CDs."

The second aspect concerns the oversimplification of the 'green' consumer. There is a perception that all environmentally aware consumers share the same ideals and opinions. A review of Enviro Loot's advertising policy run by revealed the diversity of their customer base, in common with the observations made about 'green' clients. For example, an advertisement in an animal rights magazine generated a tremendous response.

They were surprised to learn what these clients wanted;

"They wanted to invest in something which was kind to animals. We said 'how about the environmental considerations?' And they did not give a fuck. We said 'how about people?' They said 'we do not give a fuck. We like cuddly pussy cats, and we like foxes and we like elephants. We don't care about people and we don't care about the environment'."

Other 'ethical' and spiritual magazines reflect concerns about third world development and workers rights. Many of the ethical themes are emotive and often associated with a 'feel good factor', and may be entirely unrelated to environmental issues. This post-modern fragmentation of identities, blurring of social, ethical and environmental questions is compounded by a lack of understanding about many of the underlying, frequently confusing and overlapping issues.

6.3.2 Information Received.

It is crucial that firms constantly monitor trends in environmental policy development, and there is a growing demand for this information. This part reviews some of the issues and problems in dealing with such matters experienced by the enterprises. The interviews revealed three key areas; professional sources of information, the competitive advantages of such information, and how it contributed to market differentiation.

Half the firms in this sub-set are heavily dependent on acquiring and processing high quality, reliable information to support their businesses. Professional organisations were thought to be useful sources of information and guidance. For example, Enviro Loot relies on a service that screens investments for suitability, and also contributes to their competitive advantage over financial consultants that do not use this facility.

As a result of 'imperfect knowledge' those consultants may sell a product based purely on brand name or financial performance, where the 'greenness' of some funds may be highly questionable, and potentially misleading;

"You get a lot of cases where somebody has been sold something which says 'incredibly green environmentally sensitive fund' which only invests in small portable nuclear powered child abuse."

Environmental information can also be used for market differentiation. The Eco Word publisher cultivates suitable authors who will ensure continued economic success for the imprint, and deal with a particular 'green' niche because they have identified a growing market for the kind of material that addresses the business case for the 'triple bottom line'.

The problems arise when firms experience difficulties with obtaining independent, reliable, high quality environmental information. For example, Green Info relies on government press releases because they have been unable to locate a central reference point for health, safety or environmental information. The problem is compounded by the quantity of information now available.

Firms are inundated with environmental data, but cannot be expected to be technically expert in every new aspect. Green Build architect articulated the problem with reference to 'environmentally friendly' paint;

"Quite a lot of this is knowing whether you are having the wool pulled over your eyes. I'm not a chemist...I've read a bit about it, but I don't comprehend it fully."

He was aware that the chemistry of paint is extremely complex, and emphasises the demand for strong analytical skills to assess the validity of 'green' claims. It also reflects the application of the precautionary principle often exercised by these firms.

6.3.3. Summary.

- Information, such as publicity material and company reporting is crucial to ensure client retention and extend the customer base.
- These services operate as information-intensive 'gatekeepers', and occupy a powerful position to diffuse 'green' practices and technologies.
- Practical examples of sustainable technologies and award schemes are needed to accelerate diffusion.
- There is often confusion between ethical and environmental beliefs. The profile of environmental consumers is complex.
- Firms depend on reliable, high quality, impartial information. It can help these firms maintain a competitive advantage and differentiate from other businesses in the same sector.
- Firms and individuals need strong analytical skills to assess the validity of information.
- There is growing market demand for this 'green information' niche.

6.4. Indirect Environmental Impacts of Services.

This part of the analysis addresses the indirect environmental impacts of the services. It differs from the following section in that it details how the firms in this study are able to influence the nature of the resources, energy, distribution and waste arising from the eventual delivery of the service. This can be illustrated with reference to an architectural practice.

The practice itself may be a minor consumer of resources, with a low environmental profile, which will be discussed in greater depth in section 6.5. In contrast, the purpose of the service is to create buildings, over which they can exert considerable influence of the characteristics and environmental impacts.

The scores derived from the ranking system applied indicates that the services believed they could exert the greatest effect in the selection of materials and energy related issues, followed by the application of LCA thinking, and finally concerns for 'end-of-life' and transport and packaging.

The analysis follows the pattern of the eco-wheel, as used to assess the environmental impacts of products described in Chapter 5. The transcripts indicate that the environmental facets addressed through the services can be divided into five discrete categories, and outlined in Figure 6.5.

Figure 6.5. Indirect Environmental Impacts of Services.

- | |
|--|
| <p>6.4.1. Materials; including selection of 'green' alternatives, avoidance or reduction of toxins, conservation of resources, waste reduction, use of recycled material, reducing materials where possible.</p> <p>6.4.2. Energy; including conservation in use, use of renewables, consideration of energy embodied in materials.</p> <p>6.4.3. Distribution; Transport of goods delivered to organisations, and goods leaving premises. Includes consideration of packaging.</p> <p>6.4.4. Recycling of materials or consideration of end-of-life, such as disposal or recycling.</p> <p>6.4.5. LCA Philosophy adopted or implied; for example design for durability.</p> |
|--|

6.4.1. 'Green' Materials.

The interviews show that concerns about how effective the services were at encouraging the use of environmentally sound materials in the products they ultimately depend upon was the most important.

This is itself a composite of four aspects, and will be discussed in the following sequence;

- Favouring 'green' materials
- Avoiding toxic materials where possible
- Reducing materials where relevant through 'lightweighting'.
- Reducing waste where possible.

Material selection was considered the most important issue, as all except two firms (Greencar and Eco Word) felt able to exert some influence over materials selection. Within the theme of materials, the aspects include;

- Firms accept compromises, or trade-offs in the selection of 'green' materials.
- Locating UK sources of 'green' goods, particularly for building construction is difficult.
- The UK industry for such products is small scale.
- The niche position enjoyed by these firms limits the leverage they can exert to encourage availability of such goods.
- Firms advocate the 'precautionary principle' when selecting materials.
- In this group of firms, water conservation, reduced material use and waste minimisation are promoted.

6.4.1.a 'Green' Alternatives.

The selection of 'green' materials may involve compromise. One architectural practice, GreenBuild, specialises in oak-framed houses, using UK sourced, preservative-free timber. He frequently has to choose between environmentally controversial materials, for example PVC and aluminium. In his opinion, it depends on the context of the material.

For example, the construction of photo-voltaic arrays make extensive use of aluminium, which illustrates the dilemma;

"On balance it's a good thing. There are some bad things to it, but it's providing pollution-free electricity, with very long life."

The most environmentally preferable option may not always be immediately apparent. This was illustrated by GreenAcres, which supported experimental construction techniques, material reuse and recycling where it was feasible. They reported on a case where waste polystyrene was incorporated into insulation for a building. This was viewed as a sensible reuse of a material that is normally avoided, and helped to divert some of the plastic that would otherwise have been disposed of in a landfill site. The single major constraint expressed was that there is a shortage of UK manufactured 'green' raw materials or finished goods.

In spite of difficulties experienced with locating suitable 'green' goods, both architect practices manage to source suitable construction materials, but often rely on costly imports. GreenBuild, use Swedish triple glazed window units made from durable, resinous softwood. He commented;

"You can read about all this stuff...but it's actually getting them. And then finding they're more expensive."

The problem is linked to the poor standard of construction in the UK combined with cheap transport. The products themselves may be 'green', but the interviewees were aware of the environmental burdens associated with transport. On the subject of the UK timber industry, a microcosm of the scale of the UK industry for 'green' products, EcoBuild observed;

"It's not really an industry at the moment, it's more of a craft. Our timber industry has been allowed to diminish because it's much cheaper to bring a container in from Canada. So we import 90% of the timber used in the building trade."

The problem is a combination of supply and demand. In this instance, their position of niche businesses limits the leverage they have with larger suppliers, and are unable to stimulate demand to generate supply.

The Building Society have contemplated discussing the issue with the DIY chain B&Q, and have talked to smaller suppliers, including members of the FSC (Forestry Stewardship Council), and it appears that more suppliers are entering the scheme, so more products are gradually becoming available. The problem extends from raw materials, such as timber through to finished goods.

The question of balance is important. Implicit in many decisions is the potential for exchanging one environmental burden at the expense of another, rather than achieving total reduction. The use of a particular technology may be justified if materials are produced efficiently and cleanly, and several respondents were concerned that many issues are complex, and 'green' solutions are not always immediately obvious. Locating UK produced goods is a significant limitation.

6.4.1.b Avoidance of Toxic Materials.

All the respondents were concerned about minimising exposure to toxins in materials, whether evident in the production phase or in resultant products, and actively pursue alternatives. There is often acknowledged uncertainty about proving cause and effect between effects on human health and particular compounds, so the precautionary principle is invoked. The construction industry is littered with examples of potential hazards, including PVC, cement, concrete, chipboard and even exposure to high voltage cables. The main issues can be outlined with reference to PVC and chipboard. In the opinion of GreenBuild, PVC has a poor environmental reputation because the production process involves toxic precursors, also noted by Solar Splash. PVC window frames warp, crack, discolour and are prone to cold bridging, and insulated PVC electrical cable vents gas when warm. At present, PVC is cheap, readily available and easily worked. The alternatives are more expensive and difficult to obtain, although technically superior. Chipboard is another contentious material often found in buildings. This is essentially wood chips held together with a formaldehyde based adhesive. After manufacture it releases small quantities of formaldehyde gas for a long period of time. This affects not only the occupants, but also those employed in the manufacture of chipboard, who have been known to sue firms for exposure to formaldehyde. GreenBuild observed that in Germany, new houses are left to 'off gas' for sometime to allow the formaldehyde vapour to diminish to acceptable levels.

The main conclusion is that although there is considerable uncertainty with proving 'cause and effect', illnesses such as cancer may be linked to exposure to chemicals such as formaldehyde in both production and use, and the general approach is to adopt a precautionary principle. As with 'green' materials, suitable alternatives may be difficult to obtain in the UK.

6.4.1.c Resource Conservation and Reduction of Materials Used.

Two issues dominated discussion of resource conservation. The first concerned the water cycle, including rainwater collection, conservation and sewage disposal technologies. The second was the goal of reducing material usage.

As in the selection of materials, there are compromises that demand close examination of financial value added compared to environmental benefits. Both architects, Enviro Shop and GreenAcres Building Society were all conscious that rainwater is wasted, but noted that collection and storage systems in the UK are uncommon. In an effort to resolve this problem, Enviro Shop and GreenAcres promote water conservation technologies. For example, the Building Society has funded a number of properties that are independent from conventional water and sewage systems. The designs incorporate compost toilets or reed bed systems, water storage and filtration, and the reuse of (grey) water in different applications.

Reducing the weight of goods is a previously explored eco-design option that also diminish the environmental impacts of transport, but may have hidden costs. According to one architect, it depends on the context and financial value of materials. For example, there is no advantage in reducing the weight of a rammed earth wall constructed on site, as a high thermal mass is important for energy efficiency. The important issue is that of embodied energy of material. Conversely, Green Info's training videos emphasise the advantages of 'downweighting' and programmes aimed at improving process efficiency and resource consumption. Their target audience can readily identify with the idea that reducing the weight of products coupled with greater processing efficiency almost always leads to cost reduction.

6.4.1.d Waste Reduction

Waste reduction is an obvious exercise from a purely financial perspective because of direct implications of the landfill tax. Green Build extended his responsibilities for reducing waste, and commented;

"We use everything we can on site, and we lose everything we can on site."

Green Info communicates the eco-efficiency message that waste reduction makes sound economic sense. They felt that it was important to concentrate on the costs and benefits of waste minimisation to industry. This approach allows firms to focus on processes that have the most significant environmental impacts and thereby guide effective investment in remedial actions.

This may focus on concentrated, hazardous compounds rather than bulky, inert items. The environmental costs of waste are not always associated with the greatest volume.

6.4.2. Energy.

After materials, issues surrounding energy proved to be the next most significant. Five of the firms felt they could influence energy conservation and the promotion of renewable resources, and will be discussed in this order. These interests obviously reflect the business selection criteria used in this study.

6.4.2.a Energy Conservation

Energy conservation should not be confused with energy efficiency. Conservation is the practice of reducing energy consumption, rather than its efficient use.

Both architects and GreenAcres are conversant in the various approaches to energy conservation. They are well aware that heating buildings is one of the main sources of CO₂ emissions in the UK, and argue that it is the one issue over which all designers can exert some influence. GreenBuild articulated his own concerns about being able to affect energy consumption;

"Each of these things have effects, globally, locally, personally."

These architects specialise in super insulated design solutions that exhibit rapid economic repayment and provide clients with low heating costs and increased levels of comfort. They claim that insulation is becoming a very cost-effective measure in spite of low energy prices. Another aspect of conservation is embodied energy, and has already been discussed. Both architects and GreenAcres favour local building materials where possible, including quarried stone, timber and aggregates.

6.4.2.b Use of Renewable Energy

Renewable sources of energy are those that do not use fossil fuels for power generation. Although this class also includes nuclear energy, the technologies promoted by these firms include wind and hydro-power and solar radiation. The solar systems they promote are a mixture of those designed for space and water heating and electricity generation.

An illustration of the simplest form of passive solar heating is reflected in GreenBuild's designs, where the sun heats the mass of the building that is retained through extensive use of insulation. Active systems include roof-mounted panels for directly heating water, such as Solar Tech's products, and are becoming more attractive financially, particularly in new or refurbished houses. Few firms believed that electricity generation by photo-voltaic (PV) technology was commercially viable in the UK, except for very remote properties.

The main limitations that prevent the wider diffusion of energy conservation practices are non-technical. The UK energy industry lacks systems that reward investment in resource efficiency. This can be illustrated by the 'landlord-tenant' problem. There is no incentive for the builder to invest in energy efficient technology unless they are also the occupants. The builders of self-build properties overcome this barrier. One of the architects pointed out this anomaly;

"The problem is most buildings in the UK the client and the user are two different bodies. And the client doesn't have the interest, financial or philosophical to do anything about it (energy conservation)."

The 'self build' approach to construction can make well designed, super-insulated, timber framed houses an attractive proposition.

The labour costs saved through self-build become available for investment in high quality materials, boilers and controllers.

The consensus was that energy related issues will become more important in the future, but at the moment, house buyers are more interested in low initial purchase price. The extra marginal cost of buying an insulated house is a sufficient deterrent, and not perceived as a potential sales feature. Solar and other renewable energy technologies, are rare in the UK, with the price of PV a major deterrent.

6.4.3. Distribution and Packaging.

Only three of the firms commented on the scope for reducing the impacts of transport. In practice, GreenAcres Building Society and Enviro Shop endeavoured to do most, having recognised the connection between the transport of goods and resultant embodied energy. The Building Society give consideration to projects that attempt to reduce transport volume, but this is not an aspect they can rigorously enforce, while Green Info briefly mention route optimisation. Enviro Shop was the most active, and they try to organise distribution of goods in batches and deliveries to the site by regular routes. The major constraint is time, a familiar echo of the 'Just in Time' effect on logistics. They believed that altering this perception could enable the reintroduction of alternative means of transport;

"Time is of the essence. If we had the canal system and low energy was used to propel the stuff down the canals, next week would be fine. But you don't have that in today's modern lifestyle."

Transport is an issue that many were concerned about, but felt unable to exert any degree of control. Greencar Rescue obviously focused on transport issues, as part of their campaigning activities. Delivery of their breakdown service is effected through franchises issued to a network of garages. The interviewee felt that there was scope to improve the way garages operate in the future, but he had strong reservations about being able to generate any interest in environmental issues with recovery garages at present. Greencar suggested that there were several factors involved. First, the agencies lacked information and understanding of the problems of transport, and were unwilling to introduce any changes without realising the nature of the costs and benefits.

Second, many breakdown operators were also small businesses, and infrequently replaced their recovery trucks, limiting the scope for introducing fuel efficient technology.

Finally, turning to packaging, few of the firms interviewed felt able to influence this aspect. Enviro Loot commented on two firms that they recommended for investment that manufactured low impact packaging and were also financially sound.

6.4.4. End of life and Recycling.

End of life and recycling ranked the second lowest score overall. This is not a high priority issue for the businesses surveyed, as none are actively involved in promoting the reuse or recycling of products. The two architectural practices were both motivated to recycle materials, and were aware of the cascade approach, from reuse to recycling and eventual composting of the organic fraction of waste. One commented that buildings are usually replaced for financial reasons, rather than because of material fatigue.

The firms claimed that the main difficulty with recycling in the UK is the lack of infrastructure for resource recovery and processing. Enviro shop illustrated this problem with reference to the treatment of catalytic converters, which are stored on site;

"They're (the catalytic converters) coming in and we're taking them off cars now they contain precious metals. Not all manufacturers at the moment are reconditioning them, or they're not all exchanged, or they don't all go back for weighing in for scrap. We're keeping them at the moment until somebody does it."

The quote also reveals Enviro Shop's attitude regarding an environmental problem as a business opportunity. There is no doubt that the profile of this section would be very different if one of the business sectors studied was more closely allied to waste management, but it does highlight the problem of the shortage of recycling facilities, rather than the intent.

6.4.5. Application of LCA Philosophy.

The last part of the section identifies how LCA thinking has been integrated in the firms studied. The evidence indicates four main areas;

- Regarding buildings, the regulatory structure prohibits LCA thinking by focusing on one part of the life cycle.
- Industry specific regulations fail to integrate other issues, such as aesthetics that also have an environmental dimension.
- Design for longevity is a positive economic aspect.
- Communicating LCA thinking to other industries is difficult.

The first aspect is most apparent in the two architectural practices and the shop. This reflects the position held by architects who are able to address many of the eco-design options including long product life, reduced embodied energy, 'green' material selection, limit the effects of distribution, low maintenance and recyclability. For example, there is general recognition that buildings are not short term artefacts, but represent major, long term investments. The concern extends beyond professional courtesy and embraces a personal, ethical commitment to sustainable ideals. GreenBuild observed;

"I feel it's my moral obligation to see that they (buildings) do not cost the earth. It's such a long term thing, building. It's not like designing fashion clothes. Buildings are going to be there for several generations at least...You also get a pat on the back from clients, saying 'that house is so warm, so comfortable'."

The architects were frustrated that UK building regulations failed to reflect their aspirations. This was illustrated by the way the current energy rating system is constructed. The architects suggested it could be subverted and diluted, such as by switching fuels rather than reducing energy inputs or encouraging renewable sources. It was also suggested that the current regulations and procedures for assessing the minimum level of energy efficiency oversimplified many of the environmental issues, and fail to address the environmental impacts of the entire life span of buildings;

"The (energy rating system) is basically heat loss through the fabric of the building. But there's all kinds of trade-offs. So mass house builders can wriggle out of insulating buildings properly by, for example, putting a gas fired condensing boiler in, which scores them so many brownie points...or things which are seen as desirable. So if you have a solid fuel Rayburn in your house, which is burning timber or waste wood, thinnings, coppice, whatever, you get discriminated against quite heavily...It doesn't take into account the embodied energy of the materials..they are not interested in construction or demolition (phases of the building). They don't mind where the materials come from. So you can use polyisocyanate insulation throughout the building, which is highly toxic, and poisons the people that work in the factories that make it, and has all sorts of spin-offs that pollute the air and the water. But it's a good insulating material. Whereas you could use Warmcell, which is recycled newspaper."

The architects concluded that the regulations focus on the 'use' phase of the life of a building, and ignore the impacts of potentially toxic materials or eventual demolition. The second aspect concerns regulatory myopia that fails to integrate issues of regional identity, such as endorsing the environmental benefits of locally produced building materials. This would have the effect of preserving local colour and reduce embodied energy. The legislation accepts the superficial appearance of buildings with no due regard for the origins of the materials used in construction. This approach would not automatically proscribe new techniques, and GreenBuild favour the use of a particular insulating material;

"It's a local building, it's being built from local materials. Now that might mean it could still be quite a hi-tech building. For example there is some stuff I'd quite like to use called 'woodwall slab'. It's a sort of slab board, made out of screwed up bits of forestry waste, mashed up with a bit of slurry and a bit of cement and a bit of local aggregate, and compressed into a board."

The third issue is that eco-design philosophy encourages products designed for longevity. It is in the interest of the Building Society and their mortgagees to ensure consideration of good design because mortgages are a long-term commitment. The Enviro Shop garage repair vehicles using high quality, durable components to reduce emissions.

Finally, there is the problem of communicating LCA thinking to other industries. Green Info has found it a difficult idea to present to industrial clients, largely because the language, science, practice and benefits are unconvincing or too abstract.

6.4.6. Summary.

- Materials selection and energy issues are viewed as those where the greatest influence can be exerted. There is reasonable awareness of the philosophy of LCA, while transport and recycling are less crucial activities, or beyond the direct sphere of influence of the firms considered.
- The firms aim to support the use of non-toxic, locally produced and low embodied energy materials where possible, however this frequently leads to problems of lack of availability.
- Firms are aware of complexity of environmental issues, the need for compromises and the precautionary principle.
- Resource conservation, notably water, and waste reduction strategies are encouraged.
- Firms promote energy efficiency, conservation and the use of renewable sources where possible, but are hampered through lack of reward systems.
- Firms champion many aspects of LCA thinking considered to be good environmental practice through increased product life, reduced running costs, ease of maintenance, and locally produced goods. They try to avoid short term, or fashion goods, and favour durable artefacts. For example, buildings are regarded as long term investments.
- These services are critical of current regulatory systems that address one aspect of a system, but fail to integrate other, equally valid measures.
- End-of-life, or recycling are not major issues for these firms, but this reflects the nature of the sample. It was suggested that a lack of infrastructure inhibited progress in the UK, but recycling presented new business opportunities.
- Firms were concerned about the impacts of transport, but felt disempowered largely because of the demands of JIT techniques on distribution.

6.5. The Service. Internal and Organisational Environmental Actions.

Following the indirect environmental impacts of service delivery, the next most important area concerned the direct effects of services. The transcripts revealed that the actions taken could be classified into four themes;

6.5.1. The philosophy and internal policies that directly affect environmental issues; include attitudes towards energy related issues and 'best practice'.

6.5.2. Environmental regulation that directly affects the business operation.

6.5.3. Environmental and related policies; e.g. the societal brief of sustainable development.

6.5.4. New business concepts or new business delivery with implications for environmental impact of the service. This is closely related to innovation and strategic developments.

The greatest emphasis was placed on the business philosophy followed by environmental regulations that directly govern the operation of services.

Environmental policies and reporting and new business concepts received least attention.

6.5.1. Philosophy.

Analysis of the transcripts showed the business philosophy of these services comprised several elements. The first is the care taken to ensure that their business premises reflect their environmental stance. The second reveals their approach to the complexity of environmental issues exercised through the 'precautionary principle'. The third demonstrates their commitment to wider economic and social issues, often allied to sustainable development in the workplace. It was often remarked that these firms need to be vigilant that their actions are consistent with their rhetoric. Eco Word pointed out the potential pitfalls of a publisher espousing an overtly environmental position;

"We have to be careful about, for example, the paper we print on. It would be hugely embarrassing obviously for an environmental publisher to be printing on forests cropped from ancient woodlands!"

Other services, notably Enviro Shop and the architectural practices, use their own premises to reflect their commitments to environmentalism.

The Enviro Shop is highly insulated and designed to exploit passive solar heating. It also houses rainwater collection and filtration technologies, and a self-contained sewage system. In effect, it provides demonstrations of viable, 'green' technologies, from energy conservation, use of renewable energy sources, through construction, materials, water conservation and reuse.

The second element shows how the firms react to the complexity and uncertainty of many environmental issues. They tend to adopt the 'precautionary principle', described in section 6.3, that emphasises the minimisation of risks from materials or processes. The effects on human health of long-term exposure to many compounds are currently unknown.

The third element concerns activities that influence the wider social and political context of business beyond specific environmental considerations. Some enterprises, for example, the network utilised by EcoBuild benefit from a spirit of co-operation rather than competition, exemplified by their approach to self build properties. This contrasts with the typically antagonistic relationship between contractor and client, and embraces a return to a craft based, or counter-industrial view of the value of work.

Both EcoBuild architect and the Enviro Shop identified the connections between local employment and environmentalism, as reported in chapter 4. For example, EcoBuild argued that current forestry practices, reliant on mono-culture plantations, are inherently unsustainable. The interviewee claimed that thinning forests produces multiple benefits, both environmental and social. The environmental advantages include greater ecological diversity. The advantages for employment are using wood harvested for construction instead of pulping. This would create jobs in sawmills and related areas, and reduce the UK dependence on imported timber. The ideas of local issues and regional identity expressed through architecture have also been integrated into the practices of GreenBuild and GreenAcres Building Society. Both support vernacular, unconventional construction techniques, designs and materials where possible.

There is a synergy concerning local goods. It has the effect of simultaneously supporting local industries, maintaining local identity and reducing transport demand.

6.5.2. Regulation that Directly Affects the Business Operation

None of these firms are directly involved with manufacturing, so the prime regulations are related to Health and Safety issues at their own premises. The companies tend to adopt a position of super-compliance, analogous to their attitudes to environmental regulation in general as reported in Chapter 4. This view was summarised by the video production company, Green Info;

“Ideally we want to not just comply, but go beyond compliance...I think we should be an example. If we are delivering information that advises them on good practice, and we are not carrying out that good practice ourselves, that is ethically wrong.”

The posture of ‘compliance plus’ complements their business philosophy.

6.5.3. Environmental Policies.

This section refers to the internal decision making processes in firms that have some effect on energy and general environmental issues. Just two of the firms, Enviro Shop and GreenAcres Building Society, reported they had implemented environmental policies. GreenAcres claimed they operated their own environmental and energy rating policies, but had not adopted any formal initiatives because of the costs of compliance. The interviewee observed that environmental reporting was becoming more popular, and may become a feature of the competitive landscape.

6.5.4. New Business Concepts or New Business Delivery with Implications for Environmental Impacts of the Service.

This aspect of the environmental profile is closely related to innovation and strategic business developments and the eighth (@) dimension of the eco-wheel. Half the services in this survey had contemplated how to translate the environmental implications of future business directions into practice. Two key ideas emerge. These are product stewardship and new forms of service delivery. Product stewardship is implicit in Integrated Product Policy (IPP), noted in Chapter 2.

The aim is to encourage a 'closed loop' perspective regarding materials. This view engenders a functional analysis of products, and promotes the objective of service, rather than product delivery. Green Info recognised the implications for eco-design for manufacturers;

"From that perspective, the product you are supplying may not be that at all, but it may be the use of that. Are you going to take on complete ownership?...Lifetime ownership of the materials...so you get them back, and you look at the value of them."

The functional approach to services also implies new forms of service delivery. One business, Eco Word, were receptive to alternatives to paper based literature and willing to explore new markets for delivering information, including electronic publishing. CD-ROMS and the internet. Access to the internet would also act effectively as a marketing tool, and it will be possible to put large parts of books on-line. The interviewee was sceptical about the potential for electronic communication technology to displace the use of paper. It was more likely that digital technology would complement existing formats, but the environmental impact of this shift is completely unexplored.

As reported in Chapter 2, the entrepreneur has to balance two opposing forces. New business ventures are risky, but security demands minimising the uncertainty. This is important when communicating the commercial implications of sustainable issues to business, and has been underexplored. Green Info have found it difficult to make a convincing case to industry;

"Sustainability as a concept has got to be defined more precisely in terms of what businesses can and can't do, and what they should be doing."

Some of the vital elements they think make up a sustainable business include 'design for the environment', green purchasing and managing supply chains.

6.5.5. Summary.

- The business philosophy section rated one of the highest aggregate scores, reflecting its perceived effectiveness.
- The business premises often act as an advertisement for the services. They feature practical applications of products offered. This reinforces the message that the products work in practice, not just theory.
- The business practices integrate social values, such as the value of co-operative working practices, and the general impacts on the local economy.
- The uncertainty prevalent in many environmental issues is often reflected in the 'precautionary principle'.
- The firms are non-manufacturing industries, so are exposed to little immediately relevant environmental legislation, apart from Health and Safety issues on the premises.
- They tend to adopt a 'compliance plus' stance regarding environmental legislation that affects the business operation, consistent with their general business philosophy.
- Environmental policies are uncommon and informal. For some firms, this may become a more significant competitive issue in the future.
- New business concepts could be engendered through regulations, such as product stewardship.
- Businesses could deliver their services using new technologies. This would diversify and complement rather than displace existing services. The environmental consequences of this shift are unknown.
- The implications of sustainable development for the wider business community has yet to be fully explored and explained.

6.6. The Business Community and Services.

This part of the analysis investigates the degree of influence the firms have exerted, and are affected by the wider business community. This section can be further subdivided into three categories, comprising regulation, inter industrial relations and networks and suppliers in descending order of influence.

6.6.1 Environmental Legislation, Regulation and Standards

This section can be treated as a composite measure of the influence of two forms of industrial regulation. The first set comprises legislation that govern the environmental aspects of the service sector where compliance is mandatory in order for business to operate. The second group includes industry standards and self-certification schemes as options for guaranteeing environmental performance.

6.6.1.a. Mandatory Regulation.

Given the nature of the sample of firms, it is unsurprising that legislation applicable to the construction industry dominates. This includes minimum energy efficiency requirements, planning regulations, resource conservation and waste disposal. The pressures arose exclusively from the regulatory authorities to which the firms are answerable. Compliance with standards demanded by the building industry produced divergent opinions. Regulations were viewed as either too lenient, or prescriptive, such that it restricted experimentation. The second view was summarised by the Green Acres Building Society;

"The whole issue of building is tied in with other areas, such as building regulations and so on. I would like to see little bit more flexibility in the area of building regulations. There needs to be a better way of bringing forward new ideas and materials. We seem to work on a basis of 'if it's new, it's automatically out of the window'."

Builders already have to meet minimum energy efficiency standards as part of the new building process, but both the architectural practices routinely exceed the basic standards, and were unimpressed by the degree of energy conservation currently demanded. For example, one of the architects observed that in terms of insulation, Britain lags behind continental Europe, and Scandinavia in particular;

"Our building regulations are the same as theirs were in 1920. And theirs have gone up since."

Other interviewees thought that the current system prevents the introduction of new ideas. They would prefer to permit a technology that achieves the desired standard of performance unless there is clear evidence against its use.

The UK building industry appears to be very reactive towards the introduction of new products into the market;

"Continental Europe is very far in advance of us, I think, in green construction. Things that are normal over there are greeted with bemusement by most builders."

It was noted that the UK regulations were reasonably flexible and allowed some techniques, such as 'Breathing wall' construction. In this case it has proved difficult to convince the regulatory authority that this method of avoiding condensation works. Calculations show that the technique does work, so it is allowed as an alternative route for certification, although the Building Control Officers question this method of construction, and are unlikely to know about breathing wall construction.

Planning issues were also important in presenting obstacles to the introduction of 'green' buildings. A hurdle facing GreenAcres Building Society is the issue of liability for rehabilitation of contaminated land. In principle they are keen to reuse old industrial or 'brownfield' sites, because this reduces pressure on non-urbanised areas. Other planning related matters also proved to be restrictive, particularly those introduced to preserve a local identity. The conservation objectives could be achieved in alternative ways, and also avoid the illusion that everything was built 200 years ago. The owner of the Enviro Shop faced similar problems because of his location, which is within an Area of Outstanding Natural Beauty (AONB). Planning restrictions have prevented the installation of solar panels on roofs in a designated conservation village. The problem is compounded by inconsistent local and national government policies, which seek to preserve the heritage appearance of such areas, while trying to promote environmentally sound practices. This leads to conflict;

"The Building Control and the planning regulations don't fit in with the sustainability objectives that they are being instructed on from county level downwards. There is a mismatch."

It was encouraging to note that regulatory thinking is starting to adapt in some respects, such as the increased interest in rainwater conservation technology. This is allied to the view that waste can become a raw material, as demonstrated by the growing provision for recycling. Some services are highly regulated, but not from an environmental perspective.

For example, according to Enviro Loot, the financial services industry was virtually unrestricted prior to the Financial Services Act, as reported in Chapter 4. It remains to be seen if this, and other service sectors will eventually be subjected to more stringent environmental legislation.

6.6.1.b Voluntary Agreements.

Opinion in this group of firms is divided about the benefits of voluntary industrial environmental standards. The Green Info video producers had already experienced pressure from their supply chain to conform to ISO 14001. They were approached by a large manufacturing concern to produce a video, and demanded compliance with ISO 14001. On being informed that the company was not yet registered, but operated their own environmental management system, they were threatened with withdrawal of the contract. This resulted in an unusual position for a small firm, and a dilemma for the large business. Environmental training is a highly specialised arena, and it is unlikely the firm could locate a suitable alternative. It is evident that such situations require negotiated settlements for mutual benefit. In this instance certification will provide them with commercial and public relations advantage as it will make them the only European video production company to gain the standard. The benefits of certification are twofold. Their Business Development Manager will develop his knowledge-base to gain experience of ISO14001 and then guide the company through the registration process. In turn it will also improve the company's own systems and organisation. They needed financial support from the government to achieve this goal as it proved difficult to make judgements about where to put their limited resources;

"To have those sort of drivers (ISO14001) is useful, as long as there is some kind of support."

Green Info identified a crucial weakness of the management standard that is open to cynical exploitation.

They claimed that compliance does not guarantee implementation, and cited the case of one company that tried to compromise;

"One diesel engine manufacturer suggested a version that took out the fact that diesel engines emitted particulates and dioxins. Or the motor company that asked them to remove any references to the pollution from vehicles! They will do the training to get the (ISO) 14001, or whatever, but they do not really want to talk about the negative impacts of their products."

Conversely, the retailer Enviro Shop also objected to registering with non-environmental standards, such as BS5750. For many small firms, TQM systems are extremely costly to process and implement. Although the interviewee investigated the possibility of registering for the standard, in his opinion;

"The actual paper work would mean I have to employ another person to tackle that, and that isn't sustainable at this level of business."

Other voluntary schemes used by architects include the Building Research Establishment Environmental Assessment Method (BREEAM), and has been used to guarantee quality to clients. One architect was critical of the system, and claimed it was complacent and contained some anomalies. In his opinion, although he exaggerated the lack of emphasis on energy conservation;

"They give the same amount of points for having a zero energy building as they do for having a bat box."

More positively, the BREEAM model was considered useful for rewarding easily achieved 'feel good' activities, and therefore had the potential to encourage non-green architects to consider other environmental issues.

6.6.2 Inter-Industrial Relations.

This section concerns relationships with other, related industry sectors and professions, and reflects the sample of firms. These are primarily construction related, such as planning and surveying. To a lesser extent, two other firms, Enviro Loot and Greencar Rescue interact with insurance companies. GreenAcres and EcoBuild regularly confront the planning and surveying professions.

The Building Society may argue that there is demand for radical, experimental designs, but building surveyors may over rule them because of concerns about their legal responsibilities, and their failure to recognise alternative construction techniques. This has direct implications for the valuation process, which may be lower than the Society or their clients would wish. The Society is therefore constrained by this profession, but has to maintain pressure and try to persuade Surveyors to accept alternative solutions. These concerns are also linked to planning issues and the architectural profession. EcoBuild was adamant that the profession was deeply entrenched in modernist ideas and driven by fashionable aesthetics, which represented a cultural barrier. He claimed;

“Architects are terribly aesthetic led. They go for whatever the glossy architectural magazines show. Which is usually made of glass and metal, and very crisp. The buildings I’m talking about are warm and cuddly...just not hi-tech buildings by definition. They’re relatively low-tech.”

One implication of this position is that the appearance of a building is more crucial than content, and aesthetics is linked with planning issues. This problem has been described in section 6.4. GreenBuild suggested that planners can exert some influence in preserving the superficial appearance of a local style of construction, but only from an aesthetic perspective, and do not insist on the use of local material. He was concerned that this undermined authenticity of methods and materials. The evidence suggests that although there is considerable innate conservatism in the construction industry, some influence can be effected.

The financial sector mirrors the building industry to some extent. Enviro Loot interacts with fund managers who are responsible for evaluating firms for investment. This is a complex issue, as their portfolios represent a blend of ethical and environmental concerns. Ethical issues can be relatively easily determined, but defining ‘green’ is more complex, as previously indicated in section 6.3.2;

“You can say about certain funds, they have a greenish tinge. Some have a very, very dark green tinge. Some have no green whatsoever, because they are purely negative funds. They will not invest in certain areas. Those are the ones that tend to describe themselves as ethical.”

The ethical and 'green' criteria for investment include 'positive' and 'negative' lists. Examples of negative criteria include contravention of the Greenbury committee guidelines regarding Directors' pay. Environmental concerns would also reject investment in nuclear technology, ozone depleting chemicals, green house gases and convictions for pollution.

Some funds have a positive investment agenda, and seek to support socially responsible schemes that may not be 'green'. This includes co-operatives, inner city regeneration, sheltered housing, youth-oriented projects and third world development. Other positive 'green' investment includes recycling, sustainable and renewable energy sources, environmentally-benign packaging and issues such as insulation for housing. Environmental issues are beginning to affect the insurance sector. Enviro Loot cited the response of insurance companies to the effects of global warming;

"What seems to be happening is that companies are becoming aware, particularly through things like the insurance industry, of the knock on effect of environmental damage. There was a big thing recently about general insurance companies realising that global warming was actually affecting the climate."

He thinks this led them to believe that there may be a connection between environmental pollution and weather. One possible outcome is that insurance companies will eventually introduce differential rates in favour of firms that improve their environmental profile. If a company indulges in environmentally dubious practices, not only will the premiums increase, in the event of a claim the insurance company may refuse to pay. Relations with the insurance industry is also important to Greencar Breakdown who have established a very good track record with their underwriters for economic reasons. The interviewee commented that their members tend to be well informed and able to make sensible insurance claims or avoid admitting responsibility immediately following an accident. Consequently, their losses are comparatively low;

"I think this is to do with the environmental thing. They are more careful. Our underwriters are surprised how low our claims are."

Because of this record they have been offered increasingly competitive underwriting terms. This is not a conscious effort on the part of the organisation, but a reflection of their membership.

6.6.3 Networks, Partnerships & Alliances.

This set of elements concerns the non-competitive, or co-operative aspects of the business relationships. The services interviewed all depend to some extent on well-defined networks for business support. In this respect, the two architectural practices exert most control, but the remaining companies claimed to have marginal influence.

The architects created networks of like-minded 'Associates' in addition to their professional affiliations and outlined in Chapter 4. This helps them to deliver a greater range and scope of service than one person operating alone. The range of interests in these alliances is extremely diverse, and includes expertise in renewable energy, energy efficiency, electro-magnetic radiation and Feng Shui. In contrast, GreenAcres Building Society rely on other organisations, notably the AECB to provide them with relevant information, because they are too small an organisation to do the research themselves.

The political aspirations of the services in this study should not be underestimated. Small firms tend to lack the political impact of large businesses. Greencar Rescue believed that it is axiomatic that a large membership equated with significant political influence that could be used to steer government transport policy. This organisation is actively campaigning to reduce the environmental impacts of transport. This aspect of lobbying has placed the service in a quandary;

"There is no inherent quality in the purchase of our service. In fact, by purchasing our service, if it's related to the car, you're actually damaging the environment quite heavily relative to the average population of the world."

Use of the service has been justified on the grounds that pressure groups can exert pressure on politicians, and transport is high on the political agenda. Suppliers of goods and services to businesses have the potential to force firms conform to various contractual obligations, such as price and quality.

This has been felt most keenly by Green Info and has been previously described. The reverse position has been the experience of Greencar Rescue who decided to internalise competitive pressure and introduced quality standards. Their own breakdown recovery element has been subcontracted to agencies, over which they have little influence because of lack of understanding of environmental issues. In their opinion, the delivery of any improvements is difficult to envisage because of the scale of operation. Other breakdown recovery agencies are unlikely to encourage good environmental performance without a convincing financial incentive to justify the cost. They hope to encourage garages to switch to cleaner fuels and change their driving habits, which would lead to improved fuel efficiency, and eventually encourage the purchasing of new, more efficient breakdown recovery trucks.

6.6.4. Summary.

- In common with other research into SMEs and environmental issues, Environmental Regulations can be an important business driver for some services.
- These enterprises tend to exceed the minimum provision of relevant legislation that affects the delivery of the service. Greater flexibility in the construction of regulations would recognise the contribution of 'greener' solutions.
- Some legislation is restrictive, and local and national regulations often contradictory.
- Some service sectors have no environmental provision in their regulatory framework.
- Several businesses are exposed to pressure to conform with industrial standards. Some have used it as a positive business advantage, others regard it as a prohibitive cost.
- Relations with other professions is as important as regulation.
- Certain professions are resistant to environmental issues. For example, the construction industry is rooted in a modernist aesthetic tradition, although they are not necessarily anti-environmental.
- Other industries, notably insurance, are more alert to the consequences of environmental issues, such as global climate change.
- Ethical and environmental issues often overlap, and this leads to considerable confusion.
- Business networks are also influential. Professional and informal networks of 'Associates' are crucial for increasing the range of services offered.
- For some firms, political lobbying aspirations are impeded because of small membership, unlike their mainstream competitors.
- Niche market position can be an advantage when there are no alternative suppliers of a particular service.

6.7. Concluding Remarks.

This section summarises the main points that emerge from analysis of the environmental profiles of service based firms.

- The technique for analysing the environmental impacts and influences of services, derived from the eco-wheel, seemed to be robust, and captured the information needed. The four point scale devised for analysing the degree of influence and impacts also appeared to be successful, and could be applied to other circumstances and data for verification.
- In this analysis, the importance of the themes ranged from relationships with clients, environmental information, indirect environmental impacts of services followed by the direct impacts, and finally effects on the wider business community.
- The clients of these services are heterogeneous, possessing a mixture of environmental and ethical factors. The services felt that it was vital for business success to understand the needs of their customers.
- In common with 'green' products, services provide a variety of incremental and radical solutions.
- Many firms act as information rich 'gatekeepers', and require high quality data to protect their market position.
- They reported that obtaining 'green' materials produced in the UK is difficult, in common with the experience of the manufacturing firms. The problems are compounded by other, non-technical issues, such as institutional inertia, regulations and pressures of modern industrial management techniques, such as JIT.

- The services reiterate the 'precautionary principle' and emphasise risk minimisation. They are conscious that their business practices have to match the 'green' rhetoric, and they are anxious to communicate this practice. This extends to co-operative working practices.
- As previously noted, services are not subject to a multitude of environmental regulations. Where these firms are affected, they display an attitude of 'super-compliance'. At present, few have compiled environmental reports or policies, but some thought this might be an important business activity in the future.
- The impacts of environmental regulations affected services in two ways. Standards are easily exceeded, but can also stifle innovation. Sustainable objectives do not always mesh with regulatory objectives.
- Finally, environmental issues are beginning to affect other industry sectors, such as insurance.

This concludes the chapter. The next chapter addresses the final part of the questionnaire schedule that dealt with policy issues, and led to further interviews with SME agencies and eco-design interests in both the UK and the Netherlands.

Chapter 7. Policy Implications. A Review of UK and Dutch Policies for 'Greening' SMEs.

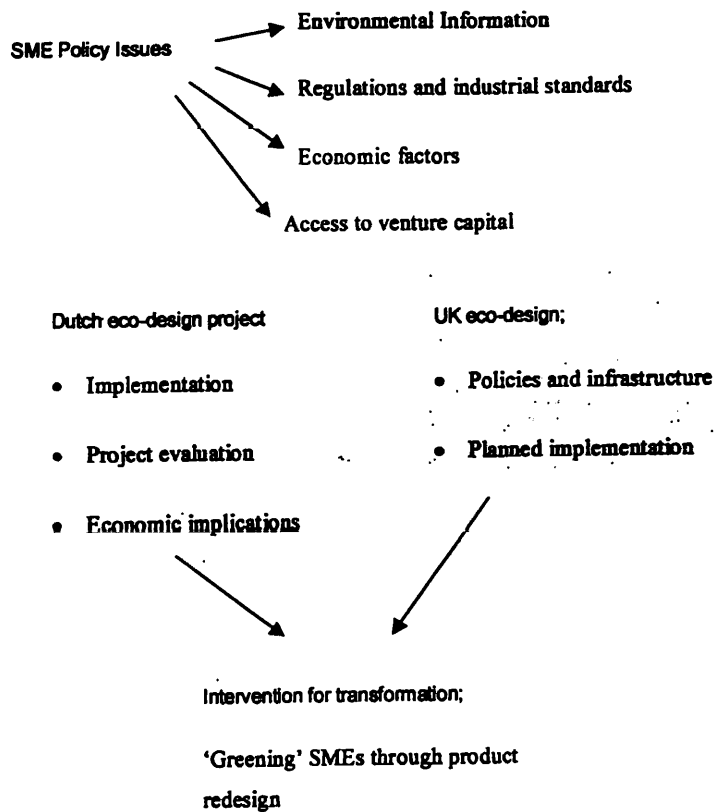
7.1. Introduction.

This chapter draws on information contained in the final section of the 14 company interview schedules that discussed barriers and incentives to further 'greening' of this selection of small firms. The evidence distilled revealed some interesting issues that have implications for the 'greening' of small businesses in the UK and could contribute to further innovation in 'green' firms. It also considers some general observations that do not directly have policy implications, but may influence business strategy and contribute to market transformation.

The structure of this chapter differs from the preceding analytical chapters as the aim of this aspect of the research project was primarily an information gathering exercise. The main objective is therefore not to present an analysis with supporting quotes, but to relate the information to the circumstances and aspirations of the firms interviewed.

The interviews showed that the key policy themes were mainly supply side issues, including information, regulations and standards, and financial intervention. These policies are largely geared to market transformation objectives, reviewed in Chapter 2, which tend to focus on encouraging non-green enterprises to modify their practices. The analysis informed further interviews with policy makers in the UK, agencies responsible for delivering environmental policies, including eco-design schemes, and those providing venture capital for the small business sector. This work was complemented with interviews conducted with the Netherlands government, SME support agencies and practitioners to discuss the effects of eco-design policies and programmes initiated in that country. The chapter concludes with a discussion of the main points.

Figure 7.1 Structure of Chapter 7.



7.2. SME Policy Issues.

The policy aspects of the interview schedule designed to investigate the government support firms had used, had found of value, or would overcome specific problems. In brief, the questions related to:

- Initiatives or policies that are available now to overcome the problems described, and what type would have been appreciated.
- What policies and support would stimulate further innovation and development of the enterprise.
- What schemes and initiatives were most beneficial.

The responses recorded show that the problems and solutions identified by the enterprises can be categorised into different types of policies.

These are:

- Information (e.g. Environmental 'Best Practice' guides)
- Regulations and Standards (e.g. ISO 14001)
- Economic Factors (e.g. Grants for R & D funding)

Most of the policy options outlined affect the supply, or production of 'green' goods and services, and include the provision of environmental information. Few address consumption, or demand.

7.2.1 Information.

The main points that emerged with regard to environmental information, including material pertaining to eco-design in a small business context, in a descending order of frequency:

- Access to independent, impartial, high quality environmental information was crucial to businesses, but difficult to locate and manage. (e.g. information from commercial organisations was treated with suspicion)
- Information based schemes could also benefit competitors, threatening market position.
- Highly specific information and training is preferred to generic material. (e.g. material directly relevant to individual business needs)
- Award scheme designed to influence 'non-green' businesses may be effective (e.g. the Architectural practices favoured the RIBA 'Green Building' award)

From a Governmental perspective, disseminating environmental information is the most rapid, easiest, least controversial and cheapest option. A major problem identified by a number of firms in this survey was access to reliable, impartial environmental information relevant to their business or geared to the needs of small firms. The collection and processing of such information is crucial for many of the firms in this study, particularly those delivering services.

For enterprises such as the architects, publisher and the video production firm, maintaining a position of 'gatekeeper' regarding environmental information can be vital for continued business success. This protects their niche against potential competitors who are reluctant or unable to deal with such material. The preferred sources included Government funded agencies such as the UK Business Links network as they were considered impartial and of high quality. Trade associations were also thought to be suitable vehicles for providing sector specific support and training. 'Green' award schemes, such as the Royal Institute of British Architects (RIBA) 'green building' initiative have been previously noted. Some interviewees thought that such awards have a marginal effect on existing 'green' businesses, but might act as spur to mainstream architectural and construction related practices to take greater interest in environmental dimensions of design.

7.2.2 Regulation and Standards.

The principle issues that concerned these small firms were:

- Regulations and standards were viewed as irrelevant to service firms. Big industries dominate the process of setting industry standards, and the process has considerable inertia. (e.g. the Eco Labelling scheme is controlled by large scale industries)
- Regulations may be useful for driving performance of laggards, as part of market transformation policies, but 'green' firms tend to exceed minimum requirements as part of general business ethos.
- Regulations tend to be too prescriptive, and reduce scope for innovation, but 'green' firms aim to influence standards and encourage flexibility.
- Opinion in this group of firms is divided about the costs and benefits of registration with industry standards. Some regard it as inevitable, but would prefer self-declaration as a cost-effective route to implementation.
- Local and national government policies are inconsistent. The planning systems are restrictive and prevent 'green' demonstration projects.
- Legislation could operate as a barrier or a stimulus for the diffusion of 'green' ideas and practices. Greater flexibility in regulations could either encourage non-green firms to switch to 'green' technologies, or limit 'green' industries.
- Environmental Industrial standards can be diffused through supply chains.
- Credit should be given to firms that reduce their environmental liability and therefore costs, such as compliance with the EU waste directives.

A strong theme emerging from the company interview transcripts is the conflicting views of the effects of regulation and industrial standards. Some firms, such as GreenStick, welcomed industrial standards as they felt it demonstrated their commitment to quality. Others, such as Solar Tech viewed standards as an unnecessary financial burden. Both regulation and standards were viewed as being both unresponsive to the needs of small businesses, and difficult to influence. Several interviewees acknowledged that large firms were capable of exercising considerable economic and political influence on the regulatory and standard setting processes by controlling markets and through the political lobbying system.

This meant that they could promote their own technologies at the expense of alternative solutions, or moderate the rate of 'greening'. Some of these firms were also convinced that there is a persistent view in industry in general that regulatory compliance always adds to industry costs and therefore reduces profits.

Opinion about industrial environmental standards, such as the ISO 14000 series, was divided. Several enterprises thought it had potential to encourage innovation, but believed the cost of compliance is probably a major deterrent for many small firms. The firms interviewed tended to prefer the cheaper option of self-declaration, thereby internalising responsibility. In contrast, some interviewees also expressed the need for greater flexibility in the interpretation of industry specific regulations to accommodate alternative, experimental technologies. This was particularly apparent with both architects, who considered that the present Building Regulations prevent real innovation, and serve to reflect the levels of performance achievable through current, mainstream technologies. Regulation in this context was viewed as a way of improving the performance of laggards rather than stimulating 'green' innovation, and relates to the process of market transformation discussed in Chapter 2. For many firms, environmental regulation was regarded as a minimum standard that was exceeded as part of the company philosophy, as previously described.

In this group of firms, there is mixed evidence that compliance with standards is being imposed through supply chains, which currently moderate practices such as energy efficiency and waste minimisation, but may eventually affect product design. Industrial standards governing product design is virtually irrelevant for service based firms.

One firm, Enviro Shop, was critical of local government policies that frequently contradicted national government strategies. For example, they claimed that local planning controls prevented the installation of rainwater collection systems on some of their buildings, although the Government's Sustainable Development policy gives implicit support to resource conservation technologies. Granting permission to demonstrate the technical credibility for 'green' technologies would be an important concession.

7.2.3 Economic Factors.

Some important financial issues that affected these small firms were apparent:

- There is a demand for low cost loans and venture capital for R&D geared to the needs of small businesses. (e.g. EcoChill needed funding to develop a non-lead acid battery for their refrigerator)
- UK Government and European funding for projects tended to be too complex, slow, bureaucratic, inappropriate and unwieldy for SMEs. The grant system favours large firms, typically requires European partners, and places high demands on staff time. (e.g. This problem was identified by EcoChill and GreenStick)
- The UK banking culture does not focus on the long-term business objectives held by these firms, and considered unsympathetic to the needs of SMEs generally.
- Support programmes need to be carefully constructed to avoid favouring 'non-green' technologies, and disparities in Regional aid packages could generate localised inequalities.
- Sector specific support could also aid or encourage competitors.
- Competitively based, payment by results, direct grant aid and matched funding favoured.

- Subsidies and tax reform that benefit 'green' technologies were the preferred options for stimulating markets. (e.g. Solar Tech suggested that removal of VAT from 'clean' fuels could transform the alternative energy market. The firm suspected such efforts might contravene European market harmonisation)
- Tax reforms can help local economies and promote 'green' schemes through the recycling of 'ring fenced' revenues. Rewards need to split incentives between supplier and consumer. (e.g. as in the EST condensing boiler subsidy scheme)
- Experience of UK government, DTI initiatives was limited, but generally useful. (e.g. Enterprise Allowance, export scheme, Support for Design).

After the problems raised by regulations, financial issues were the next most significant concern for these SMEs. Many experienced serious difficulties in locating venture capital, grants or subsidies for product research and development (R&D). One firm, Green Info, was founded using credit cards because of this problem. Financial problems were compounded in one case because of lack of other resources such as time and personnel for writing funding applications. The issue was illustrated by EcoChill's experience of trying to raise finance for extending technologies and developing a lead-acid free battery for their solar powered refrigerator. Their attempts to locate funding failed because the small scale of investment needed was too low to attract Government assistance. The interviewee recalled that bids for European funding often escalated into unwieldy projects involving other partners far beyond the scale of the resources originally required. They, and other firms that approached the UK government or European agencies often encountered a slow, complex bureaucratic process compounded by failure to locate suitable funding packages.

A commonly encountered criticism was the culture of the UK banking industry, which was thought of being geared to short term objectives, and was generally felt to be unsympathetic to the needs of SMEs. Firms felt that current practices should be changed to recognise long term management strategies and easier access to low risk finance. Venture capital is an important issue for many SMEs, and will be addressed in greater depth later.

A variety of solutions to overcome the problems outlined were proposed. One route to obtaining government and European funds was collaboration with other businesses in joint funding partnerships, which would also act as a mechanism for engendering long term business developments. The partnerships could also include other firms in supply networks.

Several respondents argued that reform of the taxation regime could transform some markets in favour of 'green' technologies. For example, Value Added Tax (VAT) on energy efficient and renewable energy technologies could be reduced or scrapped. It was felt that this move alone would dramatically increase the markets for such products.

Other proposals for financial intervention included subsidies or incentive based schemes designed to stimulate the diffusion of 'green' technologies. Subsidies were particularly favoured. An example is the Dutch programme for promoting energy efficient domestic heating through offering a discount to consumers that chose to buy gas condensing boilers (ENDS 284, 1998), a scheme replicated by the Energy Savings Trust in the UK.

Direct grant aid for enabling demonstration projects was strongly favoured to show technical credibility, a factor cited as significant in determining commercial success. This was considered important for both GreenAcres Building Society and the architectural practices, which believed they would benefit from well-publicised, high profile 'green' construction projects.

Any initiatives would have to be carefully constructed to avoid supporting inappropriate technologies or create regional inequalities. There is also the risk for concessions to 'green' technologies attracting unwanted attention from larger competitors.

7.2.4 Demand Side Issues.

In contrast to supply side initiatives and policies, few suggestions were made by the firms which have implications for stimulating the demand for 'green' goods and services. These are summarised below:

- Government policy objectives give conflicting signals to consumers. Post privatisation of the UK energy industry led to low prices, reducing the incentive to conserve energy.
- Encouraging 'greener' business and domestic consumer behaviour is crucial.
- Marketing, product labelling and financial incentive schemes could boost 'green' goods.

It has previously been noted that many businesses were forced to rely on imported products due to the limited availability of locally or UK produced 'green' goods, materials and components. It was clear that effort had to be directed at stimulating UK markets, which were currently marginalised, localised and fragmented. Demand could be encouraged through policies aimed at changing consumer attitudes and behaviour through information and financial incentives.

There is a conflict of interest in UK government policies. Privatisation of the energy industry has led to low prices, so consumers have little incentive to reduce energy consumption or increase efficiency. This has also made the markets for renewable energy sources uncompetitive.

Firms identified the need for increased publicity and marketing to communicate the advantages of a 'green' image, which would also contribute to consumer education. It was felt that product labelling would have limited impact, but consumers could be rewarded through tax or other incentives. An example was proposed by GreenAcres Building Society, who thought that 'green' mortgages should attract discounted interest rates. The way in which reward schemes are constructed was considered vital to success. The firms favoured initiatives that split the rewards between suppliers and consumers. This would have the effect of stimulating demand from both consumers and suppliers.

Some industries have begun to respond to environmental arguments. According to the investment specialists Enviro Loot, the financial sector and insurance in particular is more aware of ethical issues and the risks of pollution and climate change. It was thought that as a cost saving measure insurers may start to introduce differential rates in favour of more environmentally responsible businesses.

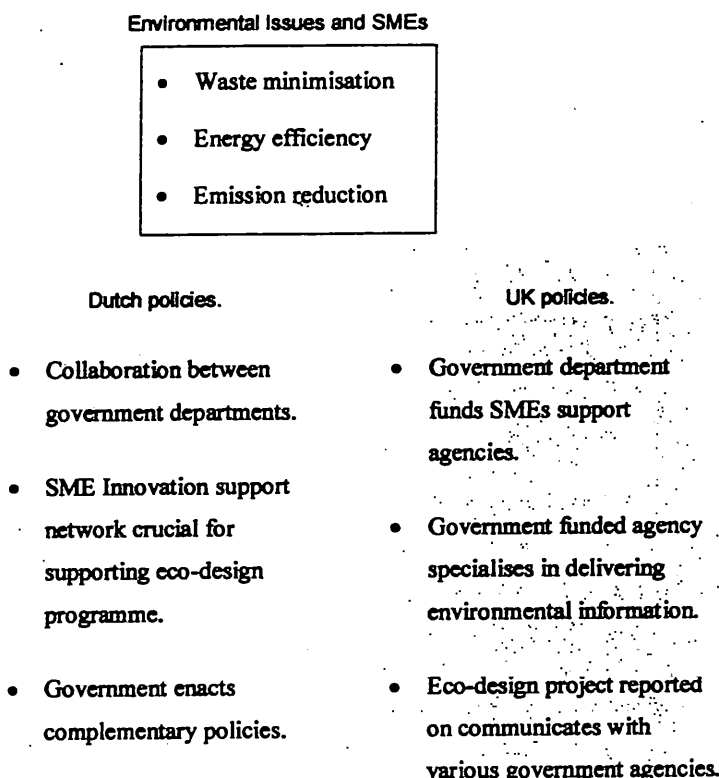
7.2.5. Review.

Some key points emerge from this review of the policy options. It is apparent that many of the observations made in this highly selective group of firms could also be applied to the broader SME community. Most of the observations relate to policies aimed at stimulating the supply of 'green' products and services. For example, information, including award schemes, can be a useful tool for diffusing 'green' ideas among non-green enterprises. Regulations and industrial standards may force laggard SMEs to accommodate environmental issues, but they are perceived as generally too inflexible and costly in this 'progressive' group of firms. Government policies were also often criticised for being inconsistent with environmental objectives. It was generally felt that initiatives were needed to promote 'green' technologies through demonstration projects, supplemented with financial incentives such as tax reform, subsidies or grants. Financing 'green' innovation has proved to be difficult. These SMEs have struggled to locate suitable funding mechanisms, and the UK banking and venture capital industries were also criticised. The issue of venture capital for small firms is dealt with in this chapter.

Previous observations (see Chapter 2) about UK government environmental assistance for SMEs has shown a focus on promoting eco-efficiency through waste minimisation and energy efficiency schemes, generally with educational material or the implementation of management systems. Some financial assistance had been offered, such as the defunct Small Company Environment and Management Assistance Scheme (SCEEMAS). The UK has yet to gain the experience of the Dutch when considering eco-design support for small firms. This was the main reason for interviewing agencies in the Netherlands that were responsible for such policies. Between 1995 and 1998 the Dutch government initiated a unique eco-design project, implemented through the small business support infrastructure. It extended the recognition of the innovative capacity of their SME community.

The next section of the chapter reviews the interviews conducted during 1998 in the UK and the Netherlands of policy makers, eco-design project managers and an UK-based 'green' venture capital company. The structure is represented below in Figure 7.2.

Figure 7.2 Eco-design and SMEs in the Netherlands and UK.



7.3. Eco-design and SMEs in the Netherlands

The general aim of schemes targeted at transforming industries in both the UK and the Netherlands has been to introduce 'non-green' firms to the economic benefits of adopting environmental practices and strategies. SMEs in both countries share some common features. Research by Spence et al. (1998) expanded on the differences in business culture, behaviour and attitudes between UK and Dutch SMEs. They concluded that the UK government policy approach to supporting SMEs has been fragmented, and in general firms have been unresponsive to regulation or voluntary initiatives, unlike their Dutch counterparts.

For example, Dutch policy makers recognised the limitations of regulations alone in resolving environmental problems. The Dutch government initiated long-term market based policies to stimulate the design of 'green' products, such as integrated chain management that promoted product stewardship. Both countries introduced schemes that originated with waste minimisation projects and subsequently evolved into the eco-design initiatives.

7.3.1. Eco-design and Dutch SMEs.

Five interviews were conducted in 1998 in the Netherlands with representatives from;

- The Dutch equivalent of the UK Department of the Environment, Transport and Regions,
- The innovation support network that implemented the eco-design project,
- An international agency that specialises in SMEs and environmental issues,
- A University that was closely involved in the early stages of eco-design initiatives,
- An eco-design practitioner responsible for analysis of the Dutch eco-design project.

The Dutch Government initially launched a series of waste reduction and pollution prevention projects. The approach used management tools to assess and define problems and formulate appropriate solutions, whose technical, economic and environmental feasibility was examined. The PRISMA project (Hartman and Böttcher, 1997) demonstrated that reducing pollution and waste at source could substantially reduce waste and emissions by some 30-40%. Many cases showed that investment in steps to reduce emissions was rapidly repaid. The project also explored how far production processes could be modified without resultant changes to products. This was the basis for demonstration projects that showed the potential for eco-design, and led to the PROMISE initiative (Brezet et al. 1994). The projects were realised through the collaboration of two ministries, Environment (VROM) and Economic Affairs, as the economic and environmental benefits were viewed as complementary. The objectives were to overcome the shortage of reliable environmental information and appropriate Life Cycle Analysis (LCA) techniques geared to the needs of SMEs.

The initial eco-design projects ran for two years, and resulted in a manual for industrial designers to appreciate environmental factors in the product design process. The experience encouraged collaboration with the electronics giant, Philips, which resulted in the firm producing its own eco-design guidelines, the 'Point of No Return' (Meinders, 1997). This was the first time product innovation and an EMS, ISO14000 had been linked. The idea of an eco-design project was then extended to SMEs, as it was known that small firms often pioneered innovative technologies and new products. In justifying the project Hartman and Böttcher (1997) commented;

"Many SMEs have neither the time, the money nor the staff to focus on environmental aspects of their own products and processes or on environmental regulations...The environment often plays only a small role in the innovation process in SMEs."

The project targeted some 5,000 firms with fewer than 200 employees that could largely define and manufacture their own products. Project management was effected through The Syntens Innovation Centres (ICs), (similar to the UK Business Links) sponsored Design Councillors, who were commissioned to introduce around 20% (900 firms) of the SMEs identified to eco-design with an 'innovation scan'. The firms selected were already known to Syntens, and believed to be receptive to environmental projects. This enabled them to identify potential firms in which to introduce eco-design strategies particularly where a 'green' champion was identified who could detect the commercial potential. This was effectively an eco-redesign programme that aimed to change the management strategies of companies in selected product sectors and to communicate the benefits of clean production and product design strategies. A major study by Hemel (1998) reported on the outcome of the implementation of the programme in 77 of the 95 participating firms. In total, the firms identified and incorporated some 600 specific eco-design related options into their products. Around one third of the improvements were generated solely because of the project. Eco-design strategies were probably assisted through the links to an Environmental Management System. Some firms reported that other design options were likely to have been either introduced regardless of the project, or the eco-design initiative enhanced the probability of successful implementation.

An example of the type of product that benefited from an eco-redesign approach is shown in Figure 7.3.

Figure 7.3. Product Redesign in Anticipation of Disassembly Legislation.

The company produces machines for hot drinks, often exported to Scandinavia and Germany. The firm is committed to accepting discarded machines ahead of anticipated legislation in those countries. The new design features two highly recyclable synthetic materials, and disassembly has been facilitated. The redesign also reduced the energy consumption of the machine.



Source: Hartman and Böttcher (1997).

Hemel (1998) reported that environmental regulations were not perceived to a prime motivating factor in most of the participating SMEs, but served a useful purpose as a trigger for innovation, as in the example shown. Regulation was rated by the firms as a crucial factor in the formulation of business decisions, and was strongly associated with customer and supplier demands. In general, the Dutch SMEs experienced little direct pressure to conform to legislation, because it rarely applied to their goods. Businesses were aware that it would become an important issue in the future, and to that extent it was concluded that regulation has a small, indirect effect on design.

7.3.2. Project Evaluation.

The product redesigns were assessed using a combination of economic and environmental indicators. This entailed an examination of how many products were successfully introduced into the market. The criteria demanded a 20% reduction in environmental impacts compared to its predecessor, identified with a comprehensive LCA, although it was acknowledged that this was a complex and controversial issue, requiring expert judgement. The future of the SME eco-design scheme is currently (2000) uncertain and is being reviewed by the Dutch Government.

7.3.3. Economic Implications.

The Dutch eco-design scheme operated through the Innovation Centres managed by the Department of Economic Affairs. This arrangement enabled them to introduce environmental policies within an economic context. In 1997 the Dutch government introduced a subsidy for small firms that covered 40% of the cost of product development and marketing. The companies were waived liability of the loan if the project failed, and to date some 5m Guilders (about £1.7m) has been directed into 25 projects, effectively providing a social credit scheme for the benefit of the country.

The schemes have been criticised for excessive bureaucracy, but this is because all Ministries are under increasing scrutiny to ensure close control of public finances. The Ministry only provided the money to firms that were unable to locate finance for environmentally-friendly products through the usual commercial routes. This is less of a problem in the Netherlands than the UK, because the tax law in Holland was changed to benefit 'green' projects. Environmental projects are tax exempt for investors, as is the capital gain from such investments. This measure alone has arguably had greater effect than the eco-design projects, and banks have experienced difficulties locating suitable projects because it is such an attractive proposition. Other government incentives considered included providing direct subsidies to businesses and reducing VAT for 'green' products, which has met with hostility from the EU. Varying VAT is problematic, but modifying tax to favour 'green' projects is easier for national Governments.

This means that environmental objectives can be realised through other measures without resorting to VAT legislation. This is an important policy issue, and will be discussed in Chapter 8.

7.3.4. Policy Implications.

A range of policies has been introduced to coincide with this new emphasis on consumer policy and environmental issues. This is likely to include information for consumers such as product labelling. At present the Dutch Government aims to encourage Environmental Management Systems in industry to enable manufacturing firms to monitor their waste streams and produce environmental reports. This will eventually develop into an environmental product management system, and it is anticipated that the government will set up a scheme that measures the effect of product modifications from an environmental perspective. This is intended to stimulate continuous improvement. There is much interest from industry, because of a subsidy that permits firms to recover 50-60% of the cost of the scheme. It is debatable if the short period of the eco-design schemes will bring about lasting changes to Dutch SMEs, and it is to be hoped that further schemes will follow, but a full range of incentives will be necessary to introduce systemic changes.

7.4. UK Eco-design and SME Support.

7.4.1 UK Eco-design: Policies and Infrastructure.

This section of the chapter details the support for SMEs in the UK, and draws on four interviews conducted in 1998 with representatives from;

- An Environmental information/Support agency for SMEs
- UK policy makers
- An SME Eco-design project
- A Venture capital company, specialising in 'green' enterprises.

The first part deals with the origins of environmental support and policies for SMEs, then considers a unique eco-design project, and finally addresses the venture capital issues previously mentioned.

UK Government interest in eco-design stems from the same concerns as their Dutch counterparts. The programmes introduced have all aimed at stimulating a 'green' transformation within industry, with particular emphasis on assisting SMEs. UK environmental initiatives tend to be delivered in the form of information, rather than as direct financial assistance. The principal government agencies responsible for the delivery for policies are the DTI and DETR. The DTI has tended to favour the establishment of regional 'one stop shops', the Business Link network, to provide SMEs with general advice including starting a small business, exporting, employment and Information Technology. The DTI operates exclusively through intermediary organisations, including Business Links and Training and Enterprise Councils (TECs). More specific programmes are run by local Environment Business Clubs and EU funded initiatives.

Environmental information and support programmes are devolved to the Energy Technology Support Unit (ETSU), which manage the various schemes under the Environmental Technology Best Practice Programme (ETBPP) programme. This includes energy efficiency advice, waste minimisation programmes and emission control and legislative compliance. They also operated the SCEEMAS project. The DTI exercise a contractual relationship with ETSU. To justify further expenditure in the agency, the Department has to demonstrate that initiatives are cost effective. This is subtly different from the aims of ETSU, whose goal is to demonstrate the general benefits of waste minimisation and energy efficiency projects to industry that deliver reduced costs and tangible environmental benefits.

ETSU also provides a 'Help line' service for SMEs as a source of impartial advice on environmental issues. The projects tend to emphasise the economic benefits realised by firms and the general cost savings to industry. The role of the ETSU as disseminators in the various Waste Minimisation schemes reviewed in Chapter 2 developed into a strategy for communicating eco-design principles to SMEs.

Small firms are encouraged to adopt environmental strategies through a 'step by step' programme that leads firms through:

1. Small, evolutionary changes in practices following the commercial benefits of waste minimisation, and involves investment in existing plant and processes.
2. The promotion of cleaner technology, defined as major step changes involving investment in new, more efficient processes and technology
3. Demonstrate the advantages of LCA as a central feature of eco-design in products.

Each step introduces new ideas, from cleaner technology, through products and processes to cleaner operations. ETSU were acutely aware that SMEs were very reluctant to use LCA, and that few tools were available to help small firms with making complex decisions. As in the Netherlands, the prospect of imminent product legislation, such as 'take back' policies spurred research into providing assistance with design for disassembly (DFD) techniques. ETSU found that firms that had benefited from their input were willing to promote their advice through their business networks. ETSU also collaborates with other Government funded bodies, such as academic research councils to promote awareness of eco-design theory and practice. The UK government has considered the implications of environmental policy and SMEs. The DTI believed that the best approach for encouraging SMEs to adopt environmentally friendly practices was through the discredited SCEEMAS (DTI, 1998).

The response from businesses to these schemes has been variable. The waste minimisation clubs appear to have been the most successful, both in financial savings to individual businesses and reductions in emissions to the environment. In 1998, ETSU reviewed the recommended 'best practice' guides based on the experience of the Aire and Calder and Catalyst projects, reported in Chapter 2. ETSU estimates that since 1994 the projects have saved industry some £25 million per year (ETSU, 1998). ETSU tries to encourage low cost, locally resourced self-help business 'clubs', and emphasise the range of technological options available, rather than prescribing solutions. They also provide initial training and expertise to ensure that the clubs endure after formal support is withdrawn. This experience has also been published to guide similar industry groups.

The main strategy that addresses environmental product design is underpinned by faith in the effectiveness of market based schemes, including product labelling, for promoting environmentally friendly goods. DETR was reluctant to entertain similar initiatives after the failure of the eco-labelling programme (BSI, 1998). The Department was concerned that products take too long to reach the market place, the scheme is costly to register and administer, and few businesses have applied.

The Department was unconvinced that EU labelling is the most effective policy mechanism, and preferred independent national, mutually recognised schemes. The DTI favoured business support delivered through the Business Link network. This would involve sector specific initiatives combined with market forces such as supply chain pressure to stimulate innovation. This effectively meant a preference for industrial, rather than government intervention.

7.4.2. Implementation of UK Eco-design Project.

Turning to the first eco-design scheme aimed exclusively at the needs of SMEs, an interview with a representative was conducted in 1998, shortly before the project became operational. It was launched in the UK with the benefit of European funding for three years, and operated through a 'Green Business Club'. The scheme has several, largely economic objectives;

- The introduction of new products and processes in 100 firms,
- Economic regeneration through employment creation,
- Improving the competitiveness of existing businesses,
- Creating new businesses.

It was anticipated that sector specific advice, augmented with supply chain management issues would be paramount. Input from larger firms in the region would also contribute to innovative product design solutions. In contrast to the Dutch project, this initiative included support for environmental technology based firms, where environmental regulations were viewed as important drivers for innovation. The scheme also aims to support enterprises that wish to adopt an environmental management system.

The UK organisation also has to be careful about not duplicating effort with other support bodies or competing with commercial enterprises that undertake environmental audits or conduct waste minimisation exercises. They were acutely aware that SMEs were constantly bombarded with information, a problem aggravated by many apparently identical organisations offering largely the same advice.

7.4.3. UK Venture Capital Industry: Some Observations.

The final part of this section draws on information from an interview with a representative from a company that specialised in providing venture capital for 'green' projects, such as renewable energy technologies. This was stimulated by comments made in the 'green' company interviews that R&D, venture capital and funds for starting businesses were difficult to locate. This continues to be a problem for SMEs in general. The main conclusions from the interview were;

- There is a problem in the UK with locating small scale, venture capital for projects that require less than £5m.
- There is a tendency for venture capitalists to seek management buy-outs (MBOs), which account for the great majority of investment.
- Only around 5-10% of venture capital is invested in starting new businesses , and that is largely focused on IT and Biotechnology.
- Financial institutions in the UK are innately conservative.
- The valuation process of small businesses is flawed, reflecting poor stock market performance.
- UK Banks have failed to support small firms, partly due to organisations increasingly removing autonomy from local managers and making judgements at higher levels.
- Venture Capital Trusts (VCTs) set up by the government have tax advantages for investors, but tend to minimise risk. They may not be suitable for 'green' technologies.

- 'Business Angels'¹ may be a good source of funding local projects. They may be unable to assess the risks associated with products that have, for example, extremely specific technical applications or export potential.
- 'Green' technologists are not automatically good entrepreneurs.
- The UK government has no strategic sense of supporting businesses of the future.

This interview suggested that UK SMEs face a number of structural problems with locating investment in R&D, but the nature of the venture capital in the UK needs to be investigated more thoroughly to verify these observations.

The problem of financing small firms is exacerbated by past government intervention in industrial sectors that has tended to support competitive issues at the expense of environmental considerations. This happened when the electricity generation and distribution systems were privatised, and affected the markets for renewable energy, despite the non-fossil fuel obligation (NFFO). The resultant low energy prices ensured that investment in the UK wind generation industry has been limited. In contrast, the Danish Government has actively intervened in supporting wind technology, and that country boasts a thriving industry.

Two broad issues emerge. It was felt that the Government and financial markets were focused on short term objectives at the expense of long term ambitions. The problem was compounded by Government Departments that rarely co-operated, unlike the Dutch ministries that combined to initiate the eco-design programme. The UK Government rhetoric differs from the detail of policy proposals, and although it set up the Venture Capital Trusts (VCTs), there is nothing that matches the tax reforms similar to those introduced in the Netherlands to encourage 'green' investment.

¹ 'Business Angels' is the term given to private individuals or groups that provide venture capital.

7.5 Summary: Intervention for Transformation.

Some key issues emerge from the interviews with the eco-design practitioners and agencies. The first three aspects are the most important issues that need to be addressed for encouraging 'green' innovation:

- Regulations and standards are unlikely to stimulate 'green' innovation.
- There are profound problems with the UK venture capital industry that affects small firms in general. Tax law changes in the Netherlands that favour 'green' projects have had arguably greater impact than the eco-design programme.
- Poor availability of 'green' goods and services in the UK is a major limiting factor.
- UK and Dutch eco-design initiatives focus on eco-efficiency programmes, and build on waste minimisation and emission reduction techniques. The Dutch projects were motivated by environmental and commercial goals.
- In this survey, few of the firms interviewed had experience of Government schemes aimed at SMEs.
- Good quality environmental information is needed, particularly by service firms to maintain their competitive advantage.

The eco-efficiency messages of waste minimisation, resource and energy efficiency has been reinforced with the application of industrial standards and management systems, designed to optimise current business practices. This research suggests that while they may serve to improve the performance of laggard companies, they are incapable of stimulating innovative solutions or extend 'green' markets.

The UK financial and banking industries were frequently criticised for being geared to short term objectives. They were felt to be unsympathetic to the needs of SMEs in general, and not just 'green' firms. Coupled to this is the problem of access to venture capital for R&D, which have not been addressed by UK policy makers, unlike the Netherlands. It was felt that the programmes that offered commercial assistance were generally regarded as too bureaucratic for the modest R&D funding sought.

Further research indicated that this problem is not limited to 'green' firms, but endemic within UK industry. Alternative strategies for the funding of 'green' projects will be discussed in Chapter 8.

A typical problem experienced by the case study firms was the availability of locally or nationally produced 'green' materials, components and final products. Firms were forced to rely on imported materials, and were keenly aware that their environmental ideals were compromised by the impact of transport. Many of these businesses recognise that they operate in niche, emerging markets. For example, water conservation is a fledgling industry compared to established energy efficiency technologies. Increased publicity and marketing efforts would be needed to communicate the advantages of a 'green' image to consumers. This raises the potential dilemma that if 'green' markets are stimulated, it will attract the attention of large competitors, possibly leading to unwanted competition.

The UK and Dutch Governments have introduced schemes designed to raise the profile of process optimisation and product design within small firms. Initiatives designed to stimulate eco-design in small firms draws on the eco-efficiency model of resource optimisation that underpin waste minimisation and energy efficiency schemes. The Dutch programme has been very successful at capturing SMEs that have previously displayed interest in innovation and capacity for absorbing environmental issues. Although the resultant innovations may have been incremental, product redesigns, the commercial and environmental benefits have been most encouraging, since firms have shown a commitment to further 'green' inspired innovation. The eco-design project reported in this study is unique in the UK, and it remains to be seen how it will develop. The firms that have received limited exposure to eco-design ideas need more encouragement to deliver further product level improvements. Initiatives aimed at advertising the benefits of clean technology to SMEs have proved to be more successful. Firms can justify investment in clean technology because the practical experience of other companies demonstrates viable solutions with quantifiable rates of return on investment. In contrast, new product development strategies demand appreciation of the economic incentives as well as the environmental imperative.

An interesting feature of firms in this survey is that few have taken advantage of the many types of incentive schemes offered to the small business community, either to assist in their formation or development. The firms interviewed for this survey experienced a range of largely non-technical limitations to wider market success that they are endeavouring to overcome.

Many of the service firms depend on their ability to collect, process and disseminate environmental information. Access to high quality, impartial, independent data maintains their competitive advantage. Environmental legislation or standards have the potential to diffuse 'best practice' by forcing non-green firms to adopt environmentally aware practices, but little has been done to address product centred environmental concerns. Regulations are unlikely to stimulate innovation in the firms in this study, which tend to regard them as a hindrance, and generally exceed standards where applicable.

Good quality, independent information is a key to disseminating best practice through industry. This material should be reinforced with access to low risk, small-scale venture capital and a review of the short term investment strategies employed by the UK financial sector. Other financial measures, such as subsidy schemes and reform of the taxation system would raise the profile of 'green' technologies. These policies would serve to diffuse desirable technologies, and combined with the dissemination of 'best practice' could stimulate a transition to more sustainable small firms. Legislation or industrial standards should reflect the needs of small firms, and alone are inadequate to deliver 'green' technical innovation. A raft of co-ordinated, ambitious proposals for the restructuring of economic institutions and new technological trajectories will be needed to secure sustainable industries. 'Green' industrial transformation within the SME sector requires an integrated approach to the implementation of these policy measures for maximum impact. This has been recognised by the Dutch Government.

7.6 Concluding Remarks.

Governments are increasing pressure on industry to adopt environmentally benign practices through the provision of information, regulation and financial intervention. The general thrust of initiatives has been to stimulate firms to reduce waste and pollution by focusing on the economic benefits of such measures. This approach has two crucial weaknesses, as the major economic and innovative contributions of SMEs have been almost completely ignored. Recent developments have begun to rectify this position with schemes that assist SMEs improve their own environmental performance and exploit their innovative potential. It is arguable this measure alone is inadequate to generate the levels of environmental improvements for businesses to become 'sustainable organisations'.

Most UK government policies aimed at encouraging market transformation from an environmental perspective have been a combination of information, regulation and occasional financial intervention through supply side measures. Relatively little attention has been paid to stimulating demand for 'green' goods. Policies and regulatory activity have typically targeted non-green firms through improvements in process efficiency and management practices. Some schemes directed at SMEs have met with little success, and support such as subsidies have proved to be more popular. Apart from isolated, uncoordinated programmes, little thought has been given to stimulating consumer demand for 'green' products apart from failed eco-labelling schemes, which are inappropriate for the majority of small firms. If there has been little research on the greening of SMEs apart from various attitude surveys, less still is known about those that may be considered as representing the 'avant garde' of environmentally aware, pro-active 'green' SMEs. In contrast, the Dutch government has been more proactive. They recognised the economic and environmental benefits that arise from a vigorous, innovative small business sector, and allocated resources to stimulate a novel environmental redesign programme.

This has been combined with changes in the taxation regime in favour of 'green' investments, and a grant scheme that subsidised the cost of SMEs to develop and market new products. There is considerable potential for the Dutch model to be transferred to the UK.

Some of the firms in this study have explored the possibilities afforded by the first stage, product improvement, of Brezet's (1997) model, driven by the commercial advantages of eco-efficiency. Other enterprises follow the product redesign trajectory by challenging conventional technologies through reformulating products and services. Several firms display a holistic vision of business, and have combined well-developed service elements. The service-based firms tend to compete in market niches avoided by their larger competitors, where their competitive advantage lies in the indirect delivery of environmental benefits.

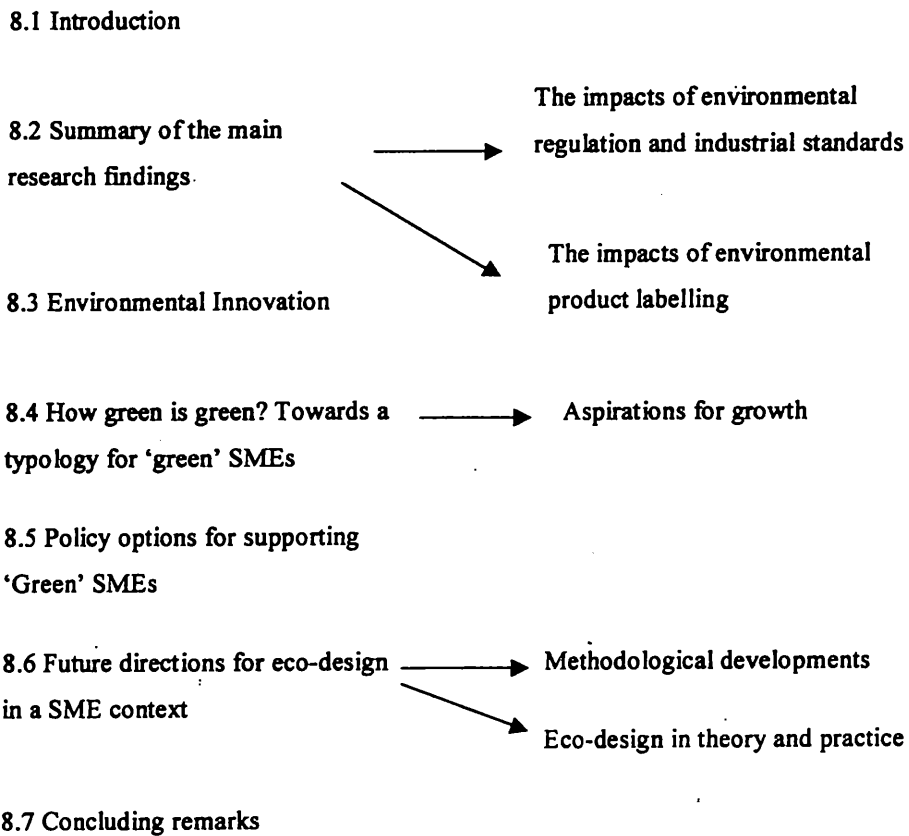
This concludes the section, and the following chapter reviews this research project and discusses the implications for eco-design futures in a small business context.

Chapter 8. Conclusions.

8.1. Introduction.

This chapter reviews the policy implications for encouraging eco-design in a small business context. It reviews the main research findings, assesses the effectiveness of market transformation policies in stimulating 'greener' production and consumption, and some future directions for research into eco-design in small firms will be explored. The outline of the chapter is shown in Figure 8.1.

Figure 8.1. The Structure of Chapter 8.



8.2. Summary of the Main Research Findings.

The main research findings are summarised in the following table, and expanded further in the chapter.

Table 8.1. Summary of Main Research Findings.

- | |
|---|
| <ul style="list-style-type: none">• The profiling techniques used to map products and services gave useful insights into the pressures on businesses and the scope for environmental innovation.• The eco-wheel was adequate for assessing the environmental profile of products, but a different approach was needed for addressing the environmental impacts of services.• These businesses were often constrained because of the lack of UK manufactured 'green' goods. There was a heavy reliance on imported products, which the firms acknowledged increased the impacts of transport and balance of trade.• Some of the enterprises studied were concerned about the wider socio-economic aspects of sustainability, such as the environmental consequences of local employment.• The businesses are superficially similar, as all were selected because of a 'green' product or service. However, this investigation revealed some important differences in business operations, motivation and aspirations. The business ideals are diverse and so are their clients. Some clients buy goods and services because of cost savings, others because of their ethical concerns.• The firms believed that many people making incremental changes in their consumption behaviour was more powerful, environmentally, than relatively few, isolated radical 'green' consumers.• The firms anticipated that growth could be realised through different strategies. For services in particular, communication technology can be a powerful tool for establishing networks, alliances and partnerships.• These firms were not only super-compliant regarding legislation, some were actively engaged in the process of setting regulatory standards.• Common beliefs expressed were that 'pollution prevention pays', and the 'precautionary principle' was frequently invoked. In this group of firms, the economic benefits of eco-efficiency are consistent with good business practices |
|---|

(Table 8.1, continued)

- The firms in this survey occupy a valuable role as 'gatekeepers', and are important agents for diffusing 'green' technologies.
- Environmental legislation is unlikely to act as a spur for innovation in most of these firms. Where it was appropriate, businesses typically exceeded the minimum requirements. This was viewed as crucial to maintaining consonance between environmental beliefs and practices. The view of industrial standards was more mixed.
- The main problems experienced by the firms in developing their businesses could be resolved through a combination of policies to stimulate demand for 'green' goods, combined with easier access to venture capital.
- Market transformation policies do not generally favour either small businesses, or eco-design practices.

8.2.1 The impacts of Environmental Legislation and Industrial Standards

The general perception that SMEs are universally reactive to environmental legislation is not supported by this highly selective group of firms. The study suggests the picture is more complex. In just one instance waste regulations were the spur for innovation. It was more common to find that these businesses routinely exceeded the minimum environmental performance demanded. This was partly because the regulations do not present a technical challenge, and partly because the firms viewed 'super-compliance' as consistent with their business ethos. Some businesses, such as Enviro Shop and the architectural practices argued that environmental regulation and standards inhibited environmentally driven innovation. This is an important point and will be discussed further in section 8.6. Services are virtually unaffected by environmental legislation, and at least two enterprises were actively engaged in establishing regulations. There was less agreement regarding voluntary industrial standards. In some firms, compliance was thought to be an inevitable consequence of competition. Others viewed it as a costly, unnecessary burden on business.

The firms in this study were sceptical that legislation or industrial standards reflected the needs of small firms, and alone are inadequate to deliver 'green' technical innovation.

Market transformation could possibly be stimulated by legislation in limited circumstances, but does not imply businesses have to integrate environmentalism any deeper than the veneer of eco-efficiency. Transformation policies are geared to 'incremental' changes, not 'radical' technologies. The effect of most policies, regulations and industrial standards is to improve the performance of laggard firms.

8.2.2. The Impacts of Product Labelling.

Product labelling may be an irrelevant tool for stimulating interest in the products featured in this group of businesses, as they tend to supply niche markets. These enterprises are not engaged in supplying goods currently under scrutiny for inclusion in environmental labelling schemes.

8.3. Environmental Innovation.

This research supports the review by Hoffman et al (1998) of innovation in SMEs namely, small firms operate in niche rather than mass markets, and their innovations range from incremental to radical. For example, a minor, or incremental, innovation from an environmental perspective is Greencar Rescue, a single issue organisation. In contrast, radical innovation is exemplified by Enviro Shop. The latter enterprise is an example of a holistic approach to business that aims to enable consumers to live nearer to sustainable ideals by supplying a wide range of goods and services. The operation also integrates local employment and social issues into considerations of sustainability.

An interpretation of Utterback's (1994) 'wave' model introduced in Chapter 2 suggests that environmental issues might stimulate innovation that could lead to technological regime shifts. Similarly, Brezet's (1997) version of this approach takes environmental issues as a primary driver. The firms in this study are representatives of the second and third stages. They either address product innovation with regard for life cycle analysis, or use current technology as a starting point for alternative solutions. For example, some enterprises incorporated clean or renewable materials and energy sources into products designed to be efficient and durable. The services are mainly redesigned variations of current service models, but have a distinct environmental angle.

8.4. How 'Green' is 'Green'? Towards a Typology of SMEs.

Superficially, the firms in this study exhibited the same basic characteristics. These enterprises all supplied 'green' goods or services. This 'green' facet obscured some deeper differences revealed by the interviews. None of the businesses represented examples of thorough eco-design practice. The eco-wheel revealed that although sensitivity to some environmental issues, for example transport, was high, the scope for reducing the impacts or changing their distribution systems remained low. The analysis of the product-based firms suggests there are two distinct types of business. These have been termed 'light' and 'dark' green respectively:

'Light green' enterprises. These firms engaged in environmental issues for purely commercial reasons. The 'greenness' in effect may only apply to limited aspects of the business, and possibly account for a minor part of the enterprise, and may not reflect deeper environmental concerns. They tend to focus on eco-efficiency strategies, such as waste reduction and energy efficiency.

'Dark green' enterprises. These firms adopt a holistic approach to business, and are rooted in 'green' technologies, or reflect a solution approach to problem solving. They have effectively translated their 'green' ideals into business practice.

Services may be either type. For example, the service provided may not be very 'green', such as Greencar Rescue. Other services operate in a 'green' organisational structure, such as the network of architects and financial consultants, or the shop that embraces a wide range of sustainable ideas. It suggests a reinvention of 'flexible specialisation' described in Chapter 2. It is possible that 'light green' firms could become 'dark green' with the right incentives, but may entail radical changes in company culture. The business types and their characteristics are summarised in a matrix shown in Table 8.2.

Table 8.2. Matrix of Company Typologies.

Typology	Manufacturing	Services
<i>Light Green</i>	<p>Engineering based firms that have shifted from conventional products towards products with improved environmental performance or benefits. They are largely driven by eco-efficiency ideas, including waste reduction and resource efficiency.</p> <p>Solar Tech, Green Stick, Solar Splash and EcoBatts</p>	<p>Non-manufacturing companies, such as retail and information intensive firms. Use of the service delivers an environmental benefit. Limited range of environmental issues addressed. 'Green' variant of conventional service.</p> <p>Green Info, GreenAcres, & Greencar Rescue and Eco Word.</p>
<i>Dark Green</i>	<p>Firms display a holistic approach to business, and were established to develop inherently green, or radically innovative, technologies.</p> <p>Fresh Water and EcoChill</p>	<p>Enterprises have holistic view of business, either in range of services or mode of operation.</p> <p>EcoBuild, GreenBuild, Enviro Shop, Enviro Loot</p>

8.4.1. Aspirations for Growth.

The growth and development strategies of the firms in this study generally match Storey's (1994) description of 'trundlers'. These are firms that survive but may not add *significantly* to job creation, and only aspire to expand on a modest scale. Regardless of their origins, all the enterprises regard growth as a critical factor. A range of different strategies for growth was apparent from the interviews. These firms stated their intention to realise measured and modest expansion, which may have significant implications for their management strategies. Flexible partnerships are more likely to be realised with the services, as they do not rely on a hierarchical structure and are essentially a federation of co-workers.

8.5. Policy Options for Encouraging Eco-Design.

This research has indicated some key policy options for stimulating innovation in 'green' SMEs. The process of industrial transformation, or the 'greening' of industry, is largely reflected in the emergence of eco-efficiency practices. Application of these principles has been advocated to resolve environmental and economic problems through increased resource and energy efficiency, waste minimisation and pollution abatement. The benefits to industry have been to increase competitiveness, avoid prosecution and increase profits.

European environmental policy reinforces this eco-efficiency approach. It has evolved from end-of-pipe prescriptive regulations, embracing market based incentives that are designed to encourage the incorporation of environmental issues in product designs. An example of this approach is illustrated by Integrated Product Policy (IPP), essentially a waste prevention measure that contributes to the market transformation policies outlined in Chapter 2. IPP increases the emphasis on producer liability and encourages a 'closed loop' through a product 'take back' approach to manufacturing.

The contrasting company case studies provided in-depth information that covered a wide spectrum of circumstances. The cases were sufficiently diverse to enable the identification and analysis of a wide range of issues, opinions and practices. These findings were internally verified by triangulating with those responsible for the formulation and implementation of eco-design and SME policy.

8.5.1 Key Policy Issues.

- The study reveals that regulations and industrial standards are inappropriate for stimulating innovation in small, 'green' firms. What is clear is that they act as drivers in encouraging improvement in the environmental performance of laggard firms. The emphasis of eco-efficiency policies has been to encourage non-green businesses to adopt environmental practices through, for example, environmental management strategies. These policies, such as the EU eco-labelling scheme, have been designed for larger firms, and are generally inappropriate for SMEs.

- The research interviews informing Chapter 7 indicated that there has been no attempt to encourage the 'green avant garde', in both the UK and the Netherlands. The Dutch Government has been more pro-active with the introduction of long term, market based incentive schemes. One initiative introduced eco-design practices to SMEs. The other, arguably the more powerful intervention, introduced 'green' tax reforms. This measure rewards innovative 'green' projects. The UK could introduce these policies although the firms interviewed favoured VAT reductions on 'green' goods. However, changes in VAT legislation are difficult to implement. The UK Government could achieve environmental objectives through alternative financial intervention under their direct control, such as incentives that reward 'green' investment, subsidies and rebates.
- There also needs to be major reforms in the UK banking and venture capital industries. The problem of locating venture capital is compounded with a banking culture in the UK that needs to be refocused towards long-term investment strategies. The major requirement for these firms was access to modest low risk venture capital, low cost loans or flexible grants for further product development. UK Government grant schemes were criticised for being inappropriate, slow and bureaucratic. The diffusion of desirable, 'green' technologies could be achieved through small scale, locally administered initiatives with matched funding, and subsidies combined with 'best practice' demonstration schemes.
- There was considerable frustration expressed due to the difficulty experienced in procuring UK produced 'green' goods and services. Firms relied extensively on imported materials, and it was suggested that effort had to be directed at stimulating UK markets for 'green' goods and services, which are often under-developed, ad hoc or fragmented. This problem affects the entire supply chain, from manufacturers through to consumers. A combination of supply and demand side measures needs to be implemented. Financial incentives for promoting 'green' goods coupled with information may encourage consumers to switch to 'green' goods and services. A public procurement policy could stimulate this demand.
- The policy intervention for promoting 'green' product development differs from that appropriate for the service sector. The services in this study require access to more information-based programmes. This could be fulfilled by a DETR or ETSU monitored and regulated register of 'green' products or services, enabling businesses to identify verified goods.

- A direct implication of market transformation is that it is possible to encourage non-green firms to become more environmentally responsible. It has not yet been investigated if it is possible to encourage 'light green' firms to become 'dark green'. The research supports Isaac's (1998) contention that it may be beneficial to direct Government support at 'green' SMEs from the outset. That is, integrate environmental ideals in new ventures, rather than introduce limited eco-efficiency strategies and management systems *ad hoc* onto existing enterprises. Research in this area could identify models of small, sustainable businesses. An untested hypothesis is that environmentally conscious or enlightened firms are not just survivors, but are more durable or sustainable, and further 'greening' their operations could be a pathway to continued growth.
- The market transformation policies are aimed at incremental changes in technologies. System level innovation (Brezet, 1997), that can deliver 'factor 10' increases in eco-efficiency that will ensure a sustainable future demands more powerful and coherent intervention.

8.6. Future Directions for Eco-Design Research in a SME Context.

Two main research topics emerge from this review. The first addresses methodological developments, the other potential future studies.

8.6.1 Methodological Developments.

The eco-wheel was adequate for assessing products, but a different form of analysis was demanded for service profiling. The revised methodology showed that alternative qualitative techniques to the eco-wheel are useful and practical. For example, it revealed that key business relationships related to how these services interacted with their clients. The technique could also apply to manufacturing firms, since the analysis drew on a wide range of information from the interview schedule, not just the section that dealt with environmental issues.

The most difficult part of the eco-wheel to assess was the section on new concept developments. The firms were unable to relate to the options outlined, such as dematerialisation. Instead, the interviewees discussed their intentions to develop applications through extending present technologies. The technique applied to the analysis of the environmental profile of services could be applied to product based firms.

The research methodology was aimed at informing SME policies. The case study approach was appropriate due to the wealth of rich data derived from case studies. It is possible that some aspects of the research reveal characteristics peculiar to these SMEs, such as their low dependency on an 'environmental champion' as in a large firm hierarchy. Some features may be common to all small firms, for example short communication and management lines. The possibility that 'green' SMEs are organisationally different remains to be investigated. This research used a largely qualitative approach, and a future project could quantify issues such as growth.

8.6.2 Eco-design in Theory and Practice.

One part of the interview attempted to identify competitors to the 'green' firms, but it became apparent that most of these businesses avoided direct competition. Their competitors were generally geographically distant, which led to collusion rather than competition. This is clearly a feature of undeveloped market niches. A future study could investigate how markets have changed, and if the technologies and services have gained new markets or expanded in other ways. This could be measured using economic indicators, such as market analysis of particular sectors or numbers employed.

The environmental analysis of the products and services has been mainly qualitative. No attempt has been made to determine the quantifiable impacts of their current activities, or how future developments would alter the profile. The style of LCA adopted is unable to convert such impacts into, for example, the equivalent in carbon dioxide emissions. A quantitative environmental analysis of the environmental profiles of the products could validate the eco-wheel approach. It would be useful to assess the potential technological contribution the goods and services could make in delivering a more sustainable future.

Research into environmental issues in SMEs has been largely limited to surveys of attitudes. There has been little attempt to identify firms that have already integrated such beliefs into their operations or translated these into products and services. More work needs to be done in this area to evaluate or compare to this research.

An area that has not been dealt with in great detail is the importance of the methods employed by the businesses to evolve from the initial inception stage or partnership structure through to the implementation of management hierarchies.

The businesses are not static entities, but constantly changing. A social anthropological study could explore some of the issues raised in greater detail.

Further work could contribute to understanding of how business origins, ownership and management affect growth and innovation, and possibly help to identify some characteristics of 'green' entrepreneurs.

The degree of innovation exhibited by the firms studied is also unresolved. The services appear to have copied existing business templates and introduced a 'green' or ethical dimension. This allowed them to exploit the 'metagrumpers' attitude of some 'green' consumers. It is apparent that the nature of the 'green' consumer is as complex as the businesses. It would be of benefit to identify how these issues and attitudes are resolved, and to what extent they influence client behaviour.

Eco-efficiency is the most widely adopted environmental strategy in the firms studied. The effectiveness of alternative approaches, such as industrial ecology, in a small firm context remains unknown.

Stimulating Eco-design could contribute to market transformation, as demonstrated by the Dutch programme. This harnessed the innovative capabilities of SMEs with environmental issues. The Dutch Government recognised the benefits of realising environmental and economic benefits through ministerial collaboration. The eco-design initiative addressed the potential to introduce incremental innovations through a product redesign strategy.

A future study could evaluate the feasibility of transferring the pioneering Dutch eco-design programme into the UK. This would provide the basis for an action research project.

8.7. Concluding Remarks.

This thesis has outlined how industry is being forced to incorporate environmental values, initially in response to legislation and more recently as a competitive issue. Regulation has historically targeted large-scale enterprises, which is now filtering through to smaller firms. The technical and regulatory response has also shifted from purely 'end-of-pipe' measures to address 'green' designs and eco design strategies. There is increasing demand for smaller enterprises to respond to this challenge. Small firms have an important role to play within the post-Fordist restructuring of industry.

They have great capacity for developing innovative solutions arising from the increasing demand for environmentally conscious goods and services. A succession of Government initiatives has encouraged firms to increase resource and energy efficiency, and reduce waste and pollution through the provision of information, regulation and financial intervention, often combined with management systems. Schemes have tended to focus on the economic, rather than the environmental benefits of such measures. A few enterprises have absorbed the ideas of eco-efficiency and moved beyond these practices and incorporated other 'green' aspects within their product or service innovation. Some firms have been founded upon environmental and sustainable values. Those in the 'green' avant garde demand particular policy attention. Regulations are unlikely to stimulate 'green' innovation, and incentives such as favourable taxes for investment in 'green' projects and eco-design programmes will be needed if they are to achieve greater economic success. 'Green' SMEs will remain marginalised in niche markets unless major policy initiatives are introduced. There is massive unrealised innovative and commercial potential while environmental problems continue to mount.

Research Publications.

Eco-Design Innovation in Small and Medium Sized Enterprises.

Paper presented at the 6th International Greening of Industry Conference. Developing Sustainability: New Dialogue, New Approaches. University of California, Santa Barbara, November 16-19, 1997.

Eco-design Innovation in Small and Medium Sized Enterprises; some early conclusions.

Paper presented at the 7th. International of the Greening of Industry Network Conference. Partnership and Leadership; Building Alliances for a Sustainable Future. Rome. 15-18 November, 1998.

Eco-design Innovation in Small and Medium Sized Enterprises; Towards Sustainable Business.

Paper presented at the 8th. International Conference of the Greening of Industry Network. "Sustainability: Ways of Knowing/Ways of Acting. University of North Carolina. 14-17 November, 1999.

Eco-Innovation and Market Transformation.

Paper submitted for publication in the Journal of Sustainable Product Design, July 2000.

Bibliography.

Advisory Committee on Business and the Environment. (ACBE) (1998). *Interim Report on Climate Change*. Department of Transport, Environment and the Regions, January.

ACBE (1997). *Environmental Reporting and the Financial Sector. An Approach to Good Practice*. Department of the Environment, February.

Association of Chartered Certified Accountants (ACCA) (1997). *1996 Environmental Reporting Awards, April 22nd*. Lincoln's Inn Fields, London.

ACOST (1990). *The Enterprise Challenge: Overcoming Barriers to Growth in Small Firms*. HMSO: London.

Acs, Z.J., Merck, R., Shaver, J.M. and Yeung, B. (1997). The Internationalisation of Small and Medium-Sized Enterprises: A Policy Perspective. *Small Business Economics*, 9, pp. 7-20.

AECB (1997). *Green-Pro '97'*. The Association of Environmentally Conscious Builders. (CD-ROM).

Allenby, B. (1998). Products to Services. In: 3rd. *International Conference 'Towards Sustainable Product Design'*. October 26-27, London.

Andersson, I. (1997). *The European Environment Agency and SMEs*. Copenhagen, March.

Ansoff, I. (1965). *Corporate Strategy*. McGraw-Hill: New York.

Archibugi, D and Michie, J. (1997). Technological Globalisation or National Systems of Innovation? *Futures*, 29 (2), pp. 121-137.

WS Atkins, March Consulting Group and Aspects International (1994). *Project Catalyst*. Report to the Demos Project Event, Manchester Airport, 27 June.

Atkinson, J. and Meager, N. (1994). Running to Stand Still: The Small Business in the Labour Market. In: Atkinson, J. and Storey, D.J. (eds) *Employment, The Small Firm and the Labour Market*, Routledge: London.

- Ayres, R. (1989). *Industrial Metabolism, Technology and Environment*. National Academy Press: Washington DC.
- Baba, Y., Yarima, M. and Hatashima, H. (1997). Realising the Shift Towards Closed-Loop Recycling: Strategies of the Japanese Firms. *International Journal of Innovation Management*. 1 (1), pp. 89-110.
- Bangemann, M. (1994). *Europe and the Global Information Society. Recommendations to the European Council*. EC, Brussels, May.
- Barkham, R., Gudgin, G., Hart, M. and Harvey, E. (1996). *The Determinants of Small Firm Growth. An Inter-Regional Study in the United Kingdom 1986-90*. Kingsley: London.
- Beder, S. (1994). The Role of Technology in Sustainable Development. *IEEE Technology and Society Magazine*, pp. 14-19, Winter.
- Boehmer-Christiansen, S. and Skea, J. (1991). *Acid Politics, Environmental and Energy Policies in Britain and Germany*. Belhaven: London.
- Bernardini, O. and Galli, R. (1993). Dematerialisation: Long-term Trends in the Intensity of Use of Materials and Energy. *Futures*, 25 (4), pp. 431-448.
- Bhate, S. and Lawler, K. (1997). Environmentally friendly products: factors that influence their adoption. *Technovation*, 17 (8), pp. 457-465.
- Blackburn, R. (1997). Personal Communication.
- Blackburn, R. (1996). *The Future of the Small Firm in the UK Economy*. The Third Midland Bank Small Business Lecture. Delivered at Kingston University, Thursday, 4th. July.
- Boardman, B., Fawcett, T., Griffin, H., Hinnells, M., Lane, K. and Palmer, J. (1997). *Domestic Equipment and Carbon Dioxide Emissions (DECADE). 2MtC. Two million tonnes of carbon*. Energy and Environment Programme: University of Oxford.
- Bor, J.M. and Blom, J.A.G. (1994). Environmental product Development Becomes Business. *Journal of Engineering Design*, 5 (1), pp. 55-63.

- Brannen, J. (1992). Combining Qualitative and Quantitative Approaches: An Overview. In: Brannen, J. (ed.) *Mixing Methods: Qualitative and Quantitative Research*. Aldershot: Avebury.
- Brezet, H. (1997). Dynamics in EcoDesign Practice. In: *UNEP IE: Industry and Environment*, 20 (1-2), January-June, pp. 21-24.
- Brezet, J.C., Horst, van der T. and Riele te, H. (1994). PROMISE Handleiding voor Milieugerichte Produkt Ontwikkeling. NOTA/SDU: Den Haag.
- British Standards Institute. (1998). Personal Communication.
- BSI. (1994). *British Standard for Environmental Systems: BS7750*. BSI: London.
- Bruntland, G.H. (1991). *Our Common Future*. Oxford University Press.
- Bryson, J.R. (1997). Small and Medium-Sized Enterprises, Business Link and the New Knowledge Workers. *Policy Studies*, 18 (1), pp. 67-80.
- Buchanan, D. Boddy, D. and McCalman, J. (1988). Getting In, Getting On, Getting Out and Getting Back. In: Bryman, A. (ed.) *Doing Research in Organisations*. Routledge: London.
- Burgess, R.G. (1984). *In the Field: An Introduction to Field Research*. Unwin Hyman Ltd.: London.
- Burke, M. (1997). Environmental Taxes Gaining Ground in Europe. *Environmental Science and Technology*, 31 (2), Pp. 84-88.
- Cairncross, F. (1994). In: Perspectives. The Challenge of Going Green. *Harvard Business Review*, July-August, pp. 37-50.
- Cairncross, F. (1991). *Costing the Earth*. The Economist Business Books: London.
- Caluwe, N de, (1997). *Ecotools Manual*. The Design for Environment Research Group, Manchester Metropolitan University, Manchester: UK.
- Carson, R. (1965). *Silent Spring*. Harmondsworth: Penguin.
- CEST (1998). *Dee Catchment Waste Minimisation Project*. Centre for the Exploitation of Science and Technology: London.

Christie, I. (1995). The Greening of Industry: Towards Cleaner Production in British Manufacturing. *Policy Studies*, 16 (4), Winter, pp. 29-48.

Citron, J. (1993). *Investigation of Barriers, Drivers and Needs in Environmental Education and Training: Responses from the Public and the Small Business Community Qualitative Research Report*. Centre for Environmental Education and Training. The Open University, March.

Cleaver, A. (1998). Reducing Pollution Through Cleaner Technologies. *Sustainable Technologies for a Cleaner World*. 19th. May, DTI Conference Centre, London.

CML and Pré Consultants (1990). *Simapro* (Software). Amersfoot, Netherlands, Pré Consultants.

Collins, J.C. and Porras J.I. (1994). *Built to Last: Successful Habits of Visionary Companies*. Century: London.

Commission of the European Communities, (CEC) (1996). Council Recommendation of 3 April 1996 Concerning the Definition of Small and Medium Sized Enterprises, *Official Journal of the European Communities* L107.39, 30 May.

CEC. (1995). *Proposal for a Council Directive on Energy Efficiency Requirements for New Household Electric Refrigerators, Freezers and their Combinations*. Brussels: Belgium.

CEC. (1992). Council Regulation (EEC) No. 880/92 of 23 March 1992 on a Community Eco-Label Award Scheme, *Official Journal of the European Communities*, p.4.

Coombs, R. and Tomlinson, M. (1998). Patterns in UK Company Innovation Styles: New Evidence from the CBI Innovation Trends Survey. *Technology Analysis and Strategic Management*. 10 (1), September, pp. 295-310.

Confederation of British Industry (1996). *Generating Growth. An SME Policy Checklist and Agenda*. CBI Small and Medium Enterprise Council. London, July.

Conway, S. and Steward, F. (1996). R&D Networks in Environmental Innovation: A Comparative Study in the UK and Germany. In: *Proceedings of the COST A3 'Management & New Technologies' Conference*, Madrid, June. pp.213-222.

Coyle, G. (1998). The practice of system dynamics: milestones, lessons and ideas from 30 years experience. *System Dynamics Review*, 14 (4), Winter, pp. 343-365.

Curran, J. (1996). *The Role of the Small Firm in the UK Economy*. The First Midland Bank Small Business Lecture. Kingston University, 6 June.

Curran, J. and Blackburn, R.A. (1990). *Small Business 2000. Socio-Economic and Environmental Factors Facing Small Firms in the 1990s*. Small Business Research Trust. London, January.

Curran, J. (1986). *Bolton Fifteen Years On: A Review and Analysis of Small Business Research in Britain 1971-1986*. Small Business Research Trust. London, September.

Daly, H.E. (1992). Allocation, distribution and scale: towards an economics that is efficient, just and sustainable. *Ecological Economic*, 6, pp. 185-193.

Department of Environment, Transport and the Regions (DETR). (2000). The Climate Change Levy.

<<http://www.detr.gov.uk/environment/climatechange/draft/section2/0.4.htm>>
(accessed 12 March 2000).

DETR. (1999a). *A better quality of life. A strategy for sustainable development in the United Kingdom*. London: May.

DETR. (1999b). *A Way With Waste – a draft waste strategy for England and Wales, part 2*. London.

Department of the Environment (1997). *Discussion Paper on the Wider Costs and Benefits of Environmental Policy*. Environmental and Energy Management Directorate, London, February.

Department of the Environment's Energy Efficiency Office (1993). *Helping the Earth Begins at Home; Energy-Saving Lightbulbs- The Facts*.

Department of Trade and Industry (DTI) (2000). <<http://dti.gov.uk>> (accessed 17 May 2000)

DTI (1998). Personal Communication.

DTI (1997). *The Quality Assurance Register*. London.

DTI (1996a). *Small Firms in Britain*. Small Firms Statistical Unit. Sheffield.

DTI (1996b). *The Queen's Award for Environmental Achievement*. The Queen's Award Office. London.

DTI (1993). *The Joint Environmental Markets Unit*. London.

DTi/DoE (1992). *Environmental Labelling Factsheet No. 2*. London, June.

Dermody, J. (1994). *Guidelines for Developing Environmentally Responsible New Products*. PhD Thesis, University of the West of England.

Dewberry, E. (1996). *EcoDesign - Present Attitudes and Future Directions*. PhD Thesis, The Open University.

Dewberry, E. and Goggin, P. (1996). Spaceship Ecodesign. *Co-design*, 5-6, Jan.-Mar, pp. 12-17.

Dey, I. (1993). *Qualitative Data Analysis. A User-Friendly Guide for Social Scientists*. Routledge: London.

DGXXIII (1998). The Growth and Environment Pilot Programme.
<http://europa.eu.int/en/comm/dg23/guide_en/gepp.htm> (accessed 18 March 1998).

DGXXIII (1997). *Crafts and Small Businesses; Employment through Innovation*. The Third European Conference on the Craft Industry and Small Enterprises. 20-21 November, Milan. Conclusions.
<http://europa.eu.int/en/comm/dg23/artisana/3rdconf/cc1_en.htm> (accessed 18 March 1998).

Dobers, P. and Wolff, R. (1999). Eco-Efficiency and Dematerialisation: Scenarios for New Industrial Logics in Recycling Industries, Automobile and Household Appliances. *Business Strategy and the Environment*, 8, pp.31-45.

Dodgson, M. and Rothwell, R. (1989). Technology Strategies in Small and Medium-Sized Firms. In: Dodgson, M. (ed.) *Technology Strategy and the Firm: Management and Public Policy*, pp. 145-154. Longman: London.

Dosi, G. (1988). The Nature of the Innovation Process. In: Dosi, G, Freeman, C., Nelson, R., Silverberg, G. and Soete, L (eds.) *Technical Change and Economic Theory*, pp. 221-237. Pinter: London.

Eden, L., Levitas, E., and Martinez, R.J. (1997). The production, Transfer and Spillover of Technology: Comparing Large and Small Multinationals as Technology Producers. *Small Business Economics*, 9, pp. 53-66.

Ehrlich, J. and Holdren, J.P. (1971) Impact of Population Growth. *Science*, 171, pp. 1212-1217.

EIM Small Business Research and Consulting. (1997). *The European Observatory for SMEs. Fifth Annual Report*. Report submitted to Directorate-General XXIII of the Commission of the European Communities. October.

Eisner, E. (1993). Objectivity in Educational Research. In: Hammersley, M. (ed.) *Educational Research. Current Issues*. 1, pp. 49-56. Chapman: London.

Elkington, J. (1994). Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. *California Management Review*. 36 (2), pp. 90-100.

ENDS (2000). *Report 304. Labelling, subsidies insufficient to boost energy efficient appliances*. May, pp. 36-37.

ENDS (1999). *Report 298 DTI buys "green" electricity*. November, pp. 27.

ENDS (1999a). *Report 291. UK's first "industrial ecology" project starts with brewing industry*. April, pp. 9-10.

ENDS (1999b). *Report 291 UKEB Abolished*. April, pp. 33.

ENDS (1999). *Report 288 Volvo issues externally verified product profile based on LCA*. January, pp.26-27.

ENDS (1998). *Report 284. EST claims success for energy-efficient boiler scheme*. September, pp. 36.

ENDS (1998). *Report 283. Commission beefs up proposals on take-back of old electrical goods*. August, pp. 43-44.

ENDS (1998a) *Report 282. Review of packaging regulations reveals a mountain to climb*. July, pp. 27-29.

ENDS (1998b) *Report 282. SCEEMAS scrapped due to lack of interest*. July, pp. 37.

- ENDS (1998a). *Report 279. OECD offers MAI rethink, subsidy, reform and eco-efficiency policies*. April, pp. 44-45.
- ENDS (1998b). *Report 279. Rover and Jaguar raise the stakes in greening of corporate supply chains*. April, pp. 23-24.
- ENDS (1998c). *Report 279. Environmental reporting challenge as EMAS enters second wave*. April, pp. 20-22.
- ENDS (1998). *Report 278. Government launches action plan for UK environmental firms*. March, pp. 7-8.
- ENDS (1997). *Report 274. National eco-labelling scheme is an option, says Meacher*. November, pp. 29.
- ENDS (1997). *Report 273. Government urged to push green procurement*. October, pp. 28.
- ENDS (1997). *Report 272. CBI revamps environment forum with benchmarking scheme*. September, pp. 8.
- ENDS (1997). *Report 270. Small firms benefit from waste minimisation*. July, pp. 11-12.
- ENDS (1997). *Report 267. Commission rethinks 'mini-IPPC', urges 'consent by silence' for SMEs*. April, pp. 37-38.
- ENDS (1997). *Report 265. Continuing expansion for waste minimisation clubs*. February, pp. 6.
- ENDS (1997). *Report 264. The unfulfilled potential of life-cycle analysis*. January, pp. 20-24.
- ENDS (1996). *Report 260. DoE widens small firm grants for EMAS registration*. September, pp. 33.
- ENDS (1996). *Report 252. Dow Europe and the Challenge of Eco-efficiency*. January, pp. 16-20.
- Environmental Resources Limited (ERL). (1993). *Ecolabelling Criteria for Lightbulbs*. London.

Ernst & Young and SPRU. (1998). European Commission: DGXI. Integrated Product Policy. A study analysing national and international developments with regard to Integrated Product Policy in the environment field and providing elements for an EC policy in this area. Executive Summary from the Final Report, March.
<<http://europa.eu.int/en/comm/dg11/ippsum.pdf>> (accessed 20 April 1998).

Environmental Technology Best Practice Programme (ETBPP). (1998). *Choosing Cost-Effective Pollution Control. Guide GG109*, March.

ETBPP. (1997). *Saving Time and Money Through Waste Minimisation. A Case History from the Thames Valley Waste Minimisation Project*. September.

ETBPP. (1996). *Attitudes and Barriers to Improved Environmental Performance. Industrial Environmental Management*. August.

ETSU. (1998). Personal Communication.

ECFESD. (1998). European Consultative Forum calls for Integration of Employment and Environmental Policies. December 7th.
<<http://europa.eu.int/comm/dg11/press/bio98577.htm>> (accessed 14 December 1998).

Evans, S. and McAloone, T. (1996). The Economic Life Cycle. *Co-design*, 5/6, pp. 76-80.

FAME. (2000) Financial Analysis Made Easy. <<http://fame.bvdlp.com>> (accessed 23 June 1997).

Financial Times. (1996). Cut the Theory, Let's have the Practice. November 5.

Fleming, D. (1996). *The Lean Economy. Discussion Paper Series. Paper 1. Facing up to the Reality of Low Output*. The Strategy Workshop. London. June.

Freeman, C. (1996). The Greening of Technology and Models of Innovation. *Technological Forecasting and Social Change*, 53, pp. 27-39.

Friedman, M. (1970). *The social responsibility of business is to increase profits*. The New York Times Magazine, No. 32-33, pp. 122-126.

Fussler, C. and James, P. (1996). *Driving Eco Innovation*. Pitman: London.

Galapagos Management Consultancy (1993). *A Survey of Environmental Practices in Leicestershire Companies- A Summary*. July.

Gardiner, P. and Rothwell, R. (1989). Design Management Strategies. In: Dodgson, M. (ed.) *Technology Strategies and the Firm*, pp.170-183. Longman.

Garrod, B. and Chadwick, P. (1996) Environmental Management and Business Strategy: Towards a New Strategic Paradigm. *Futures*. 28 (1), pp. 37-50.

Geiser K. and Crul, M. (1996). Greening of Small and Medium-sized Firms: Government, Industry and NGO Initiatives. In: Groenewegen, P., Fischer, K., Jenkins, E.G. and Schot, J (eds.) *The Greening of Industry Resource Guide and Bibliography*. Island Press: Washington D.C.

Glaser, B. and Strauss, A. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine: Chicago.

Glekman, H., and Krut, R. (1997). Neither International nor Standard. The Limits of ISO 14001 as an Instrument of Global Corporate Environmental Management. In: Sheldon, C (ed.). *ISO 14001 and Beyond*. pp. 45-59. Greenleaf: Sheffield.

Goedkoop, M. (1994). *Lfe-Cycle Analysis for Designers*. European Design Centre. Eindhoven: The Netherlands.

Gouldson, A. and Murphy, J. (1998). *Regulatory Realities*. Earthscan: London.

Graedel, T.E. and Allenby, B.R. (1995). *Industrial Ecology*. Prentice Hall: Englewood Cliffs, NJ.

Gray, C. (1996a). Small Firms and Quality Issues in Britain. In: *The Social Representations of Quality Among SMEs. International Colloquium of the International Association of Researchers in Economic Psychology*. Paris.

Gray, C. (1996b). Small Firm Job Creation: A Success in Spite of HRM? In: *HRM - the inside story conference*. Milton Keynes, 1-2 April.

- Gray, C. (1995). Managing Entrepreneurial Growth: a question of control? Entrepreneurship in the 90s. In: *The 18th. ISBA National Conference*. Paisley, November.
- Gray, R., Bebbington, J. and Walters, D. (1993). *Accounting for the Environment*. Paul Chapman Publishing Ltd: London.
- Green, K. and Miles, I. (1996). A Clean Break? From Corporate Research and Development to Sustainable Technological Regimes. In: Welford, R. and Starkey, R. (Eds.) *The Earthscan Reader in Business and the Environment*. Earthscan: London.
- Green, K., McMeekin, A and Irwin, A. (1994). Technological Trajectories and R&D for Environmental Innovation in UK Firms. *Futures*, 26 (10), December, pp. 1047-1059.
- Groenewegen, P. and Vergragt, P. (1991). Environmental Issues as Threats and Opportunities for Technological Innovation. *Technology Analysis and Strategic Management*, 3 (1), pp. 43-55.
- Groundwork Trust (1998). *Small Firms and the Environment*. Executive Summary.
- Grubb, M., Koch, M., Munson, A., Sullivan, F. and Thomson, K. (1993). *The Earth Summit Agreements. A Guide and Assessment*. Earthscan: London.
- Hammersley, M. (1999). *Case Study Method: A Brief Introduction and Bibliographical Guide*. Occasional Research Paper Series No. 6. The Open University.
- Hammersley, M. and Atkinson, P.A. (1995). *Ethnography: Principles in Practice*. Tavistock/Routledge: London. 2nd. Edition.
- Hammersley, M. (1992). Deconstructing the qualitative-quantitative divide'. In: Brannen, J. (ed.) *Mixing Methods: Qualitative and Quantitative Research*. Aldershot: Avesbury.
- Hajer, M. (1995). *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Clarendon Press: Oxford.
- Halfpenny, P. (1979). The analysis of Qualitative Data. *Sociological Review*, 27 (4), pp. 779-825.

- Harper, P. (1996). Getting Through to Sweden. *Clean Slate, The Journal of the Alternative technology Association*. 20, Spring, pp. 10-11.
- Harrison, J.F.C. (1975). The Iron Machine. In: Barker, T. (ed.) *The Long March of Everyman*. pp. 11-28. Andre Deutsch: London.
- Hartman, R. and Böttcher, H. (1998). *EcoDesign: benefit for product and environment. Environmental Product Development for small and medium sized enterprises. Review of the 1995-1997 period*. Syntens vestiging. Amsterdam. April.
- Hartman, R. and Böttcher, H. (1997). *EcoDesign. Benefits for Product and Environment. Results of the EcoDesign Project of the Network of Innovation Centres in 1995 and 1996*. Innovatie Centrum. Amsterdam-Haarlem. March.
- Hass, J.L. (1996). Managerial ('Green') Management Typologies: An Evaluation, Operationalization and Empirical Development. *Business Strategy and the Environment*, 5, pp. 59-68.
- Hemel, C.G. van (1998). *EcoDesign Empirically Explored*. PhD Thesis, Delft University of Technology, The Netherlands.
- Hemel, C.G. van and Brezet, H. (1997). *EcoDesign; A promising approach to sustainable production and consumption*. United Nations Environment Programme, Paris.
- Hemel, C. G. van (1996). Experiments in Dutch ecodesign. *Co-Design*, 5-6, pp. 84-87.
- Henstock, M. (1994). *Design for Recyclability*. The Institute of Metals, 1, Carlton House Terrace. London.
- Hillary, R. (2000). Introduction. In: Hillary, R. (ed.). *Small and Medium-Sized Enterprises and the Environment. Business Imperatives*. pp.11-22. Greenleaf: Sheffield
- Hillary, R. (1997). Environmental Management Standards: What do SMEs Think? In: Sheldon, C. (ed.) *ISO 14001 and Beyond*. pp. 333-355. Greenleaf, Sheffield.
- Hillary, R. (1995). *Small Firms and the Environment: A Groundwork Status Report*. Groundwork, November.

- Himmelberger, J.J. and Brown, H.S. (1995). Global Corporate Environmentalism: Theoretical Expectations and Empirical Experience. *Business Strategy and the Environment*. 4, pp. 192-199.
- Hinnells, M.J. (1995). *Evaluation of Environmental Impacts of Domestic Appliances and implications for Public Policy*. PhD Thesis, Institute of Advanced Studies, Manchester Metropolitan University, September.
- Hippel, E. von (1988). *The Sources of Innovation*. Oxford University Press: London.
- Hoed, van den, R. (1997). An Exploration of Approaches Towards Sustainable Innovation and their Implications on the Product Development Process. In: *The Greening of Industry Conference*. November 16-19, Santa Barbara.
- Hoffman, K. Parejo, M. Bessant, J. and Perren, L. (1998). Small Firms, R & D, Technology and Innovation in the UK: A Literature Review. *Technovation*. 18 (1), pp. 39-55.
- Holstein, J.A. and Gubrium, J.F. (1995). *The Active Interview*. Sage: London.
- Holt, D., Anthony, S., and Viney, H. (1998). Greening SMEs in the United Kingdom: Partnerships, Alliances and Support Networks. In: *The 7th. International Conference of the Greening of Industry Network*. Rome, November.
- Horst, van der, T.J.J. and Zweers, A. (1994). Product Focused Design Strategies within the context of the NEPP. *Journal of Engineering Design*, 5 (1), pp. 37-44.
- Hukkinen, J. (1995). Green Virus: Exploring the Environmental Product Concept. *Business Strategy and the Environment*. 4, pp. 135-144.
- Hunter, C., Evans, P. and Peirson-Hills, A. (1997). The Business Impacts of Sustainable Development Policies in Europe. In: *Proceedings of the Business Strategy and the Environment conference, September 18-19, University of Leeds*. pp. 124-129.
- Hutchinson, A. and Hutchinson, F. (1997). *Environmental Business Management. Sustainable Development in the New Millennium*. McGraw Hill: Maidenhead, England. pp. 196.

Hutchinson, A. and Chaston, I. (1994). Environmental Management in Devon and Cornwall's Small and Medium Sized Enterprise Sector. *Business Strategy and the Environment*. 3 (1), pp.14-22.

International Institute for Industrial Economics (IIIEE). (1997). *Background Note, Environmental Management Operational Information for SMEs "Relevant information and operational tools"*. International Expert Meeting, Lund University, April 3-4.

Intergovernmental Panel on Climate Change (IPCC) (1996). *Climate Change: Impacts, Adaptations and Mitigations of Climate Change*. Cambridge University Press: Cambridge.

Isaak, R. (1998). *Green Logic. Entrepreneurship, Theory and Ethics*. Greenleaf: Sheffield.

Jackson, T. (1994). *Cleaner Production Strategies*. Stockholm, Environment Institute/Louis Publications.

James, P. (1999). Services. Objective: Sustainable Solutions 2020. In: *The 4th. International Conference 'Towards Sustainable Product Design'*. Centre Borschette, Brussels. July 12-13.

Kemmis, S. (1993). Action Research. In: Hammersley, M. (ed.) *Educational Research. Current Issues*. 1, pp. 177-190. Chapman: London.

Kemp, R., Schot, J. and Hoogma, R. (1998). Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management. *Technology Analysis and Strategic Management*. 10 (2), pp. 175-195.

Kimmel, A.J. (1988). *Ethics and Values in Applied Social Research*. Sage: London.

King, N. (1994). The Qualitative Interview. In: Casell, C. and Symon, G. (eds) *Qualitative Methods in Organisational Research*. Sage: London.

Korten, D.C. (1995). *When Corporations Rule the World*. Earthscan: London.

Krebs, C.J. (1985). *Ecology*. 3rd Edition. Harper and Row: New York.

Langrish, J. (1988). Methodologies for Art and Design research. The Matrix of Research in Art and Design Education. *Conference organised by the London Institute and CNAA.*

Leopold, A. (1949) *A Sand County Almanac*. New York: Oxford University Press.

Lovelock, J. (1979). *Gaia: A new look at life on Earth*. Oxford University Press: Oxford.

Loveman, G. and Sengenberger, W. (1990). Economic and Social Reorganisation in the Small and Medium-Sized Enterprise Sector. In: *The Re-Emergence of Small Enterprises-Industrial Restructuring in Industrialised Countries*. pp. 1-61. International Institute for Labour Studies, Geneva.

Lyotard, J-F. (1992). *The Post Modern Condition: a Report on Knowledge*. Manchester University Press.

Malim, T., Birch, A. and Wadeley, A. (1992). *Perspectives in Psychology*. Macmillan: London.

Manzini, E (1996). Design in Transition. *Eco design*, IV (1), pp. 15-16.

Manzini, E (1990). Limits and Possibilities of Ecodesign. In: *Cleaner Production 6.1*. Canterbury, September 17-20.

Mannion, A.M. and Bowlby, S.R. (eds). (1992). *Environmental Issues in the 1990s*. Wiley: Chichester.

Mason, C., Harrison, J. and Harrison, R. (1988). *Closing the Equity Gap? An assessment of the Business Expansion Scheme*. Small Business Research Trust, London.

McDonough, W. and Braungart, M. (1998). *The Next Industrial Revolution*. The Atlantic Monthly, October.

McGie, T. (1999). If at first you don't succeed...*The Guardian*, 25th. May.

McLaren, D., Bullock, S. and Yousuf, N. (1998). *Tomorrow's World*. Earthscan: London.

- McLaren, J., Wright, L., Jackson, T. and Parkinson, S. (1997). Dynamic Life Cycle Modelling for use in Decision-Making: The Case of Mobile Phone Takeback and Recycling. In: *Proceedings of the 5th LCA Case Studies Symposium*. SETAC, Brussels, 2nd. December.
- Meadows, D.H, Meadows, D.L., Randers, J and Behrens, W.W. (1979). *The Limits to Growth*. MIT report for the Club of Rome. Fifth Edition. Pan Books Limited: London.
- Meadows, D.H, Meadows, D.L. and Randers, J. (1995). *Beyond the Limits*. Earthscan: London.
- Meinders, H. (1997). *Point of no return*. Philips Electronics N.V. Eindhoven, September.
- Miles, B. and Huberman, A.M. (1984). *Analysing Qualitative Data: A Source Book for New Methods*. Sage Publications: London.
- Moffatt Associates Partnership (1996). *The 1996 UK Business and the Environment Trends Survey. Summary of Main Findings*. London.
- Mintel Special Report (1991). *The Green Consumer 1991*. London, UK.
- Mintel International (1994). *The Green Consumer*. London, UK.
- Mitchell, J. (1969). "Introduction" and "The Concept and use of Social Networks". In: Mitchell, J. (ed.) *Social Networks in Urban Situations*. pp. 1-50. Manchester University Press.
- Murphy, J. and Gouldson, A. (1997). Exploring The Theory Of Ecological Modernisation: Assessing The Impact Of Environmental Policy On Industrial Innovation. In: *ESRC Workshop, 24th. September*. Westminster County Hall, London.
- Murray, J.B. and Ozanne, J.L. (1991). The Critical Imagination: Emancipatory Interests in Consumer Research. *Journal of Consumer Research*, 18, pp. 129-43.
- Nelson, R.R. and Winter, S.G. (1977). In search of useful theory of innovation. *Research Policy*, 6, pp. 36-76.

- New, S., Green, K and Morton, B. (1998). Greening Public Procurement: a review of the issues. In: *The Greening of Industry Network, 7th International Conference, November 1998, Rome.*
- OECD (1996). *The Environment Industry.* The Washington Meeting. Paris.
- OECD (1991). *The state of the Environment.* Paris.
- Office of Technology Assessment (1992). *Green Products by Design: Choices for a Cleaner Environment.* Congress of the United States, Office of Technology Assessment, Washington DC.
- Palmer, J. (1997a). *Environmental Management for Smaller Organisations: Overview and Conclusions (draft).* Eclipse Research Consultants, Cambridge, July.
- Palmer, J. (1997b). *Informing Smaller Organisations about Environmental Management: An assessment of central government schemes.* Eclipse Research Consultants, Cambridge, July.
- Patton, M.Q. (1980). *Qualitative Evaluation and Research Methods.* London: Sage.
- Pearce, D.W., Markandya, A and Barbier, E.B. (1989). *Blueprint for a Green Economy.* 3rd Edition, Earthscan: London.
- Petts, J., Herd, A. Gerrard, S. and Horne, C. (1999). The Climate and Culture of Environmental Compliance within SMEs. *Business Strategy and the Environment.* 8, pp. 14-30.
- Piore, M.J. and Sabel, C.F. (1984). *The Second Industrial Divide. Possibilities for Prosperity.* Basic Books: New York.
- Popper, K.R. (1968). *The Logic of Scientific Discovery.* Hutchinson: London.
- Porter, M.E. and Van der Linde, C. (1995). Towards a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives,* 9 (4), pp. 97-118, Fall.
- Potter, S with Dewberry, E. (1993). EcoDesign Management: A Comparative study of companies in Europe and the USA. In: *5th. International Forum on Design Management Research and Education.* MIT, July, 14-16.

Rackham, O. (1986). *The History of the Countryside*. Dent: London.

Regency Corporation Limited in Association with the United Nations Environment Programme. (1998). *Sustainable Business. Economic development and environmentally sound technologies*. London.

Ribó, J.M. (1995). The Catalanian Institute of Technology: Helping Industrial SMEs in Environmental Management and Cleaner Production. In: *The 2nd. European Roundtable on Cleaner Production and Cleaner Products*. Rotterdam, pp. 13, November.

Rocci, S. (1997). *Towards a New Product-Service Mix*. MSc. Thesis in Environmental Management and Policy. Lund, Sweden, September.

Roberts, N. (1994). The Global Environmental Future. In: Roberts, N. (ed.) *The Changing Global Environment*. Blackwell: Oxford.

Roome, N. (1994). Business Strategy, R & D Management and Environmental Imperatives. *R & D Management*, 24, pp. 65-82.

Roome, N. (1992). Developing Environmental Management Strategies. *Business Strategy and the Environment*, 1 (1), pp. 11-24.

Rothwell, R. (1992). Developments Towards the Fifth Generation Model of Innovation. *Technology Analysis and Strategic Management*, 1 (4), pp. 73-75.

Rothwell, R and Zegveld, W. (1982). *Innovation and the Small and Medium Sized Firm. (Their Role in Employment and in Economic Change)*. Frances Pinter: London.

Rothwell, R., Freeman, C., Horsley, A., Jervis, P., Robertson. and Townsend, J. (1974). SAPPHO Updated- Project SAPPHO Phase II. *Research Policy*, 3 (3), pp. 258-291.

Roy, R. (1994). The Evolution of ecodesign. *Technovation*, 14 (6), pp. 363-380.

Rural Development Commission. (1996). *Green Audit Kit*. Salisbury.

Schmidheiny, S. (1992). *Changing Course. A Global Business Perspective on Development and the Environment*. Business Council for Sustainable Development. MIT Press, Cambridge.

- Schofield, J.W. (1993). Increasing the Generalizability of Qualitative Research. In: Hammersley, M. (ed.) *Educational Research. Current Issues*, 1, Pp. 91-113. Chapman: London.
- Schot, J. and Fischer, K. (1993). The Greening of Industrial Firm. In: Schot, J. and Fischer, K. (eds.) *Environmental Strategies for Industry: International Perspectives on Research Needs and Policy Implications*. pp. 3-36. Island Press: Washington.
- Schumacher, E.F. (1973). *Small is Beautiful. A Study of Economics as if People Mattered*. Blond and Briggs: London.
- Schumpeter, J.A. (1934). *The Theory of Economic Development*, Cambridge Mass: Harvard University Press.
- SETAC (1991). A Technical Framework for Life-Cycle Assessment. In: *Workshop report from the Smugglers Notch, Vermont, August 18-23, 1990*. USA.
- Shrivastava, P. and Hart, P. (1995). Creating Sustainable Corporations. *Business Strategy and the Environment*, 4, pp. 154-165.
- Simon, M., Evans, S., McAloone, T., Sweatman, A., Bhamra, T. and Poole, S. (1998). *Ecodesign Navigator- A key resource in the drive towards environmentally efficient product design*. Manchester Metropolitan University, Cranfield University and EPSRC.
- Smith, M.T., Roy, R. and Potter, S. (1996). *The Commercial Impacts of Green Product Development*. Design Innovation Group, The Open University, DIG-05, July.
- Smith, M.T. and Potter, S. (1996). Ecolabelling and environmental policy: policy confusion persists. *Policy Studies*, 17 (1), pp. 73-80.
- Smith, M. (1993). *An Evaluation of the EU Eco-Labeling Scheme and Compact Fluorescent Electric Lighting*. MSc. Thesis, Lancaster University.
- Spence, L.J., Rutherford, R., and Blackburn, R.A. (1998). *Small Business and Environmental Issues in the UK and the Netherlands: A Literature Review and Research Agenda*. Kingston University Small Business Research Centre. SBRC 5-98, May.
- Stake, R.E. (1995). *The Art of Case Study Research*. Sage Publications: London.

- Stake, R.E. (1994). 'Case Studies', In: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of Qualitative Research*, Thousand Oaks, Sage.
- Starik, M., Throop, G.M., Doody, J.R. and Joyce, M.E. (1996). Growing an Environmental Strategy. *Business Strategy and the Environment*, 5, pp. 12-21.
- Stead, W.E. and Stead, J.G. (1996). *Management for a Small Planet. Strategic Decision Making and the Environment*. Sage Publications: London.
- Steger, U. (1993). The Greening of the Board Room: How German Companies are Dealing with Environmental Issues. In: Fischer, K. and Schot, J. (eds.) *Environmental Strategies for Industry: International Perspectives on Research Needs and Policy Implications*, pp. 147-166. Island Press: Washington.
- Storey, D. and Karlsson, C. (1998). Editorial. *Small Business Economics*, 10, pp. 1-4.
- Storey, D. (1994). *Understanding the Small Business Sector*. Routledge: London and New York.
- Stott, M. (1996). Morally Making Money. *Town and Country Planning*, pp. 171, June.
- Strauss, A. and Corbin, J. (1990). *Basics of Qualitative Research. Grounded Theory Procedures and Techniques*. Sage Publications: London.
- Street, P. and Barker, B. (1995). Promoting Good Environmental Management: Lessons from BS 5750. *Journal of Environmental Planning and Management*, 38 (4), pp. 483-503.
- Talbot, R. (1998). *New Business, New Scotland*. Thirdwave/Scottish Borders Enterprise.
- Temple, P. (1997). *Design and Competitiveness: The Role of Industrial Standards. End of Award Report for the Design Council*. Design Council, London. January.
- Thurston, D.L. (1994). Environmental Design Trade-offs. *Journal of Engineering Design*, 5 (1), pp. 25-36.
- Tibbs, H.B.C. (1992). Industrial Ecology: An environmental agenda for industry. *Whole Earth Review*, Winter.

- Tiler, C., Metcalfe, S. and Connell, D. (1993). 'Business Expansion Through Entrepreneurship: The Influence Of Internal And External Barriers To Growth', In: Dodgson, M. and Rothwell, R. (eds.) *International journal of Technology Management, Special Publication on Small Firms and Innovation*, pp. 119-132.
- Toffler, A. (1980). *The Third Wave*. Pan: London.
- Tuppen, C. (1998). The social dimension of sustainable development and its relationship to product design. In: *The 3rd. International Conference 'Towards Sustainable Product Design'*, DTI Conference Centre. London, October 26-27.
- UNEP (1997). UNEP-WG-SPD News and Research Programme.
<<http://unep.frw.uva.nl>> (accessed 23 April 1998).
- Utterback, J.M. (1994). *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*. Harvard Business School Press, Boston, Massachusetts.
- Verheul, H. and Vergragt, P.J. (1995). Social experiments in the Development of Environmental Technology: A Bottom-up Perspective. *Technology Analysis and Strategic Management*, 7 (3), pp. 315-326.
- Vickers, I. and Cordey-Hayes, M. (1999). Cleaner Production and Organizational Learning. *Technology Analysis and Strategic Management*, 11 (1), pp. 75-94.
- Wackernagel, M. and Rees, W. (1996). *Our Ecological Footprint*. New Society Publishers: British Columbia, Canada.
- Weizsäcker, E. von, Lovins, A.B. and Lovins, L.H. (1997). *Factor Four. Doubling Wealth-Halving Resource Use. The New Report to the Club of Rome*. Earthscan: London.
- Wallace, D. (1996). *Sustainable Industrialization*. Royal Institute of International Affairs: London.
- Weenen, H. van. (1999). *Design for Sustainable Development. Practical Examples of SMEs*. European Foundation: Dublin.
- Welford, R. (1997). *Hijacking Environmentalism. Corporate Responses to Sustainable Development*. Earthscan: London.

Welford, R. (1996). *Corporate Environmental Management. Systems and Strategies*. Earthscan: London.

Welford, R. and Jones, D. (1994). *Measures of Sustainability in Business. A Report of a Consultation and Networking Exercise funded by the ESRC Global Environmental Change Programme*. Centre for Corporate Environmental Management, October.

Weston, C. (1996). Poor record of small firms that fail to deliver the jobs. *The Guardian*, 24 December.

Womack, J.P., Jones, D.T. and Roos, D. (1990). *The Machine That changed the World*. Rawson Associates: New York.

Wong, V., Turner, W. and Stoneman, P. (1995). *Market Strategies and Market Prospects for Environmentally Friendly Consumer Products*. Warwick Business School Research Bureau, Paper No. 165. University of Warwick, Coventry, March.

Woolgar, S., Vaux, J., Gomes, P., Ezingear, J-N. and Grieve, R. (1998). Abilities and competencies required, particularly by small firms, to identify and acquire new technology. *Technovation*, 18 (8-9), pp. 575-584.

World Commission on Environment and Development. (1987). *Our Common Future*. Brundtland Report, Oxford University Press: Oxford.

Yin, R.K. (1994). *Case Study Research: Design and Methods*. Second edition. Thousand Oaks: Sage.

Appendix. The Interview Schedule.

Questionnaire/Oct97



Commercial - In
Confidence

DESIGN INNOVATION GROUP

Eco-Design Innovation
in Small and Medium
Sized Enterprises

Product Based Company

Questionnaire Number

Name and position of Interviewee

Name of Company

Address

.....
.....
.....

Telephone

Fax

e

Email/

Date of

Website

Interview

Permission to record

☐

Permission to quote

☐

Brief description of the 'green' product.....

.....
.....

Section 1. Background Information on the Company.

- 1.1 Please give a brief history of the firm, including; origins, ownership, changes in size (over last 5 years), changes in markets, other significant developments, (e.g. change of ownership).
- 1.2 To whom do you sell your products?
e.g. Direct to consumers (Retail), Wholesalers, Other small businesses, Public Sector/large organisations.
- 1.3 What are the main issues currently on your business agenda?
e.g. Competition (effects of imports?), supply chain pressure, quality assurance issues, management systems (BS5750, EMAS), Legislation (e.g. Health & Safety, product liability), Environmental issues, other(s).
- 1.4 Have you considered what issues are likely to influence company strategy over the next 5 years?
- 1.5 How have voluntary schemes, such as certification systems or codes of practice affected the business?
e.g. product certification, management systems, IIP, quality assurance, Environmental Management Systems (EMS) or other environmental awards.
- 1.6 How do you see the company developing in the future, for example in terms of market development?
- 1.7 If the company is planning to expand, how do you intend to manage development?
e.g. Organic growth, acquisition, change of status.
- 1.8 If not, what are alternative strategies?
- 1.9 What size would you like the firm to be (turnover, employees)?
- 1.10 Do you envisage a change in the balance between the product and service aspects of the business?

Section 2. Environmental Issues.

- 2.1 What are the main areas of environmental legislation which affect your company?
e.g. Duty of Care, EPA (1990), COSHH, IPC, Control of Water Act, packaging legislation, Landfill Tax, Energy labelling.
- 2.2 What action have you taken to comply with these regulations?
- 2.3 Did this achieve or exceed the required level of compliance?
(If exceeded, ask why this was done)
- 2.4 Are there any voluntary environmental initiatives you are aware of?
e.g. Clean technology, clean processes, waste minimisation schemes, Eco-labelling, Energy Efficiency, EMAS, Environmental Audits and Reporting, ISO14001.
- 2.5 Do you participate in any of these schemes?

Section 3. The Green Product.

This section refers specifically to _____, the 'green' product.

- 3.1 What proportion of turnover does this 'green' product represent?
- 3.2 What are the markets for the product?
(i.e. How do they relate to 1.2?)
- 3.3 What were the reasons for developing a 'green' product?
i.e. Internal and external stimuli.
e.g. supply chain pressure, legislation and regulation, 'environmental champion', commercial/market advantages, competitor pressure.

- 3.4 Did you undertake a commercial evaluation of the costs and benefits of developing the 'green' product?
If 'yes', what were the **Costs**? e.g. Development of technology, investment in equipment, internal/external barriers.
What were the **Benefits**? e.g. New markets, export potential, marketing material, awards.
- 3.5 What gives the 'green' product a competitive advantage compared to alternative products which fulfil a similar function?
e.g. price, quality, environmental performance.
- 3.6 Did the company consider any alternatives when developing the 'green' product?
(If so, why were they rejected?)
- 3.7 Who are the main competitors which supply conventional, 'non-green' alternative products which fulfil a similar function?

Company Name/Location	Product
1.....
2.....
3.....

- 3.8 Are there any other competitors who supply 'green' products that fulfil a similar function?

Section 4. Environmental Impacts of the Product.

- 4.1 What environmental issues did you address in the design of this product?
- 4.2 What environmental issues do you intend to address in future developments of this product?
- 4.3 Returning to 4.1, categorise and rank the responses as appropriate in the following table, and follow up any issues not specifically covered.
- 4.4 Identify the **barriers** which had to be overcome, and the **stimuli** which enabled the firm to achieve the score for each issue.
- 4.5 What specific actions did you undertake to address these issues?

(Using the responses, explore how receptive the company would be to further information/training about Life Cycle design.)

Ranking scheme.

0 = The issue was irrelevant,

1 = The issue was not addressed/regarded as unimportant

5 = The issue was fully employed

Irrelevant Not addressed

Fully
employed

0

1

2

3

4

5

1 Selection of low impact materials, including; cleaner materials, renewable materials, lower energy content materials, recycled materials, recyclable materials.

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2 Reduction of material usage, including; reduction in weight, reduction in (transport) volume

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3 Optimisation of production techniques, including; alternative production techniques, fewer production steps, lower/cleaner energy consumption, less production waste, fewer/cleaner production consumables.

--	--	--	--	--	--

4 Optimisation of the distribution system, including; less/cleaner/reusable packaging, energy efficient transport mode, energy efficient logistics.

--	--	--	--	--	--

Irrelevant	Not addressed		Fully employed		
------------	---------------	--	----------------	--	--

0	1	2	3	4	5
---	---	---	---	---	---

5 Reduction of impact during use, including; lower energy consumption, cleaner energy sources, fewer consumables needed, cleaner consumables, reduce wastage of energy and other consumables.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

6 Optimisation of initial lifetime, including; easier maintenance and repair, modular product structure, classic design, stronger product-user relation.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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7 Optimisation of end-of-life, including; reuse of product, remanufacturing/refurbishing, recycling of materials, safer incineration.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

8 New concept development, including; dematerialisation, shared use of product, integration of functions, functional optimisation of product (components).

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Section 5. Support for Business

- 5.1** What initiatives/policies are available now to enable you to overcome any barriers described?
- 5.2** What type of support would have encouraged you to overcome the barriers mentioned?
- 5.3** What would have enabled you to make further progress at the time of the product development?
- 5.4** Do you intend to develop the product further? If 'yes', how?
- 5.5** What support/initiatives would you need to achieve this development?
- 5.6** What initiatives would enable the company as a whole to develop further?
- 5.7** Thinking about the company in general, what schemes/initiatives do you feel were most beneficial? How were they useful?